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The JOURNAL *of* HEREDITY

(Formerly the American Breeders' Magazine)

A MONTHLY PUBLICATION DEVOTED
TO PLANT BREEDING, ANIMAL BREEDING AND EUGENICS

PUBLISHED BY THE
AMERICAN GENETIC ASSOCIATION
(Formerly called the American Breeders' Association)

VOLUME VI

WASHINGTON, D. C.
1915

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r16.69282 Jan 7.

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American Genetic Association
511 Eleventh Street N. W., Washington, D. C.
UNITED STATES OF AMERICA

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THE JOURNAL OF HEREDITY, 1915

The

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Vol. VI, No. 1 January, 1915

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The Journal of Heredity is published monthly by the American Genetic Association (formerly called the American Breeders' Association) for the benefit of its members. Fifty per cent. of the annual membership fee is specifically designated as payment for the Journal. Canadian members who desire to receive it should send 25 cents a year, in addition to their regular membership dues of $2, because of additional postage on the magazine; foreign members pay 50 cents extra for the same reason. Price of single copies, 25 cents.

Entered as second-class matter August 27, 1912, at the postoffice at Washington, D. C., under the act of August 24, 1912.

Date of issue of this number, December 30, 1914.

LEAD AS A RACIAL POISON

That lead poisoning can effect the germ-plasm of guinea pigs is indicated by experiments under way at the University of Wisconsin. These photographs of results were supplied by Professor Leon J. Cole, who writes: "Each of the photographs shows two young from the same litter, in all cases the mother being a normal (non-poisoned) albino. In each of the litters the white young is from an albino father which received the lead treatment, while the pigmented offspring is from a normal homozygous pigmented male. While these are, it is true, selected individuals, they represent what tend to be average rather than extreme conditions. The albino male was considerably larger than the pigmented male; nevertheless his young average distinctly smaller in size. Note also the brighter appearance of the pigmented young one." (Frontispiece.)

See Live-Stock Genetics, p. 21

SEXUALITY IN PLANTS

Observed But Not Understood by Babylonians and Assyrians—Not Proved Experimentally Until Seventeenth Century—Early Observers Hampered by Lack of Proper Methods—Evolution of the Problem Largely Due to a Few Great Men.[1]

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FROM the beginning of man's thoughtful consideration of natural processes, the phenomenon of sexual reproduction, with the associated phenomena of heredity, have persistently engaged his keenest interest. The primary fact of the necessary concurrence of two individuals in the production of offspring was, in the case of animals, recognized from the beginning. The equivalent phenomenon was not established for plants until the end of the seventeenth century. At this time, however, little more was known of the essential features of the sexual process in animals than had been familiar to Assyrians, Egyptians and Greeks twenty centuries before.

Of the additions made since 1700 to our knowledge of sexual reproduction, of its varied types and of the associated phenomena, no mean share has been contributed by botanical investigators. Noteworthy among such contributions are the work of Koelreuter and Mendel in the production and systematic study of plant hybrids, and the early work of Pfeffer on the chemoatactic response of spermatozoids. Of more recent work we may cite that of the plant cytologists on apogamy and apospory, on multinucleate sexual cells or gametes, and on the long-delayed nuclear fusion in the sexual reproduction of the plant rusts. It should then be of interest for us to consider just how and when the more important steps have been taken in building up the vast mass of somewhat incomplete knowledge that we now possess concerning the reproductive process in plants. Because of exigencies of time and patience, I shall confine myself primarily to an attempt to picture the chief steps by which our present knowledge of the essential sexual process, the union of two parental substances, has been attained. Incidentally, we may note the changes in point of view of investigators and in their mode of attack on this problem. I shall attempt to suggest the trend of development more clearly by often grouping the chief phenomena discovered in such a way as to indicate the sequence of discovery, within each group, of the different phases of the sexual process, though the order of discussion may thus not always accord with the sequence of the discovery of individual phenomena in plants as a whole.

WORK OF GREAT MEN.

In following the evolution and change in aspect of our problem we shall often find it best to keep a few relatively great names prominent. This will serve in the first place to make the story more vivid and intelligible. It will at the same time often come nearer the essential truth, for in each great forward step some one worker has usually been the dominating leader.

The first discoveries pointing to the existence of sex in plants were evidently made very early in human history by

[1] Address of the vice-president and chairman of Section G, Botany, American Association for the Advancement of Science, December, 1913. (This address, in its complete form, was published in *Science*, N. S., Vol. XXXIX, pages 299-319, 1914.) The illustrations have general bearing on the subject discussed and were selected as being more readily intelligible than the detailed technical drawings of the early investigators, whose works are referred to.

THE DATE PALM AMONG THE ASSYRIANS

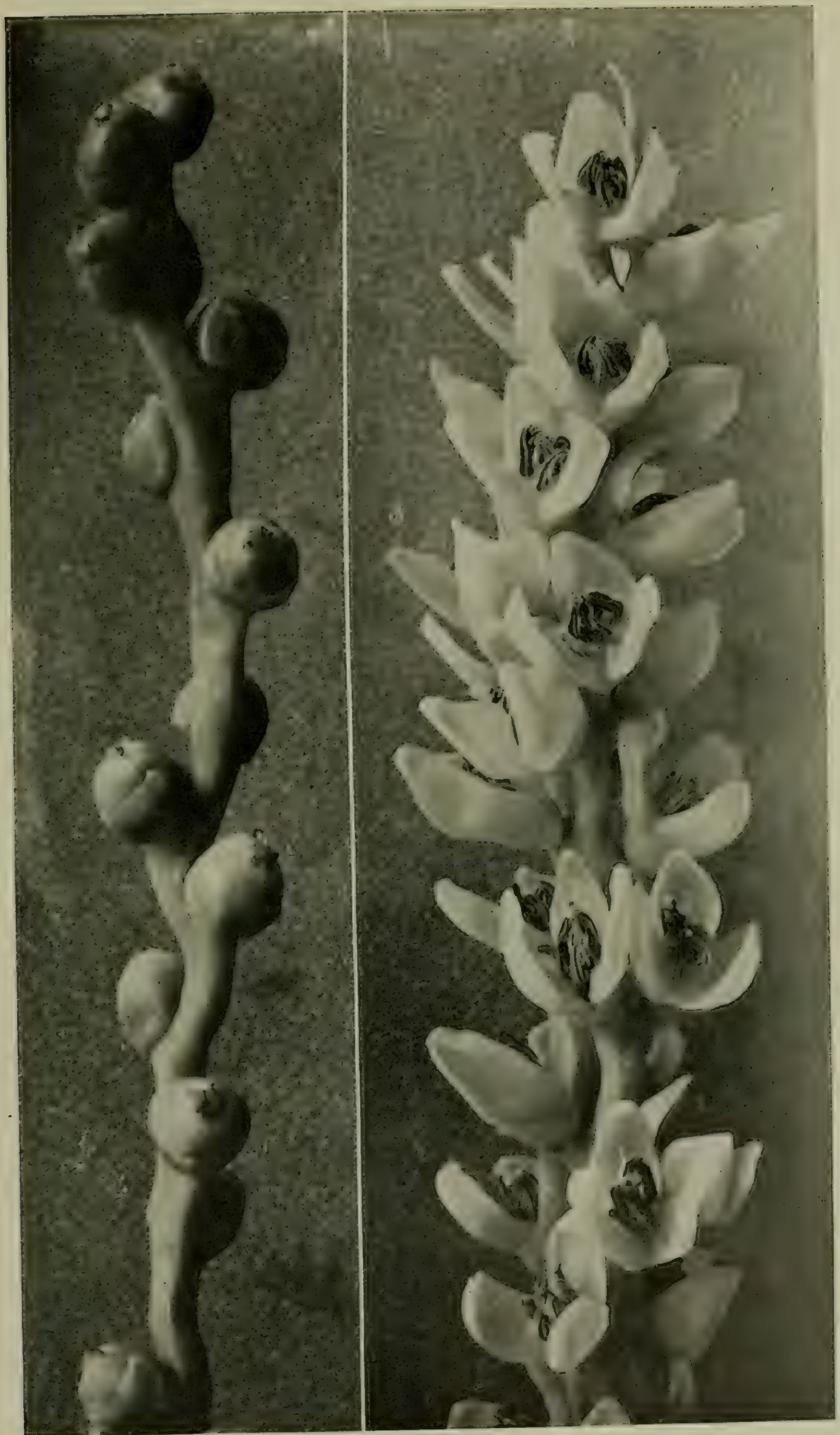
Design from the palace of Sargon at Khorsabad (eighth century B. C.) showing that the male and female flowers of the date palm were clearly distinguished at that time. The worshiper in the middle is carrying a sprig of male or staminate flowers while the one at the right bears female or pistillate blossoms. The drawings should be compared with the photographs of actual flowers in fig. 2. The winged deity at the left, who is usually identified as the Palm God, holds in his hand a cone which is thought to typify the spathe of the male palm, and thus the principle of fertility in general. (Fig. 1.)

peoples cultivating unisexual plants for food. The existence of fertile and sterile trees of the date palm, *e. g.*, was known to the peoples of Egypt and Mesopotamia from the earliest times. Records of the cultivation of these trees and of artificial pollination have come down to us on bas-reliefs from before 700 B.C. found in the palace of Sargon at Khorsabad (Haupt and Toy, 1899).[2] The Assyrians, it is said, commonly referred to the two date trees as male and female (Rawlinson, 1866). The Greeks, in spite of their peculiarly keen interest in natural phenomena, failed to offer any definite interpretation of this well-known fact concerning the date palm. Aristotle and Theophrastus report the fact, gained apparently from the agriculturalists and herb-gatherers, that some trees of the date, fig and terebinth bear no fruit themselves, but in some way aid the fertile tree in perfecting its fruit. But without recording a single crucial experiment on the matter, Theophrastus concludes that this can not be a real sexuality, since this phenomenon is found in so few plants.

EARLY GUESSES.

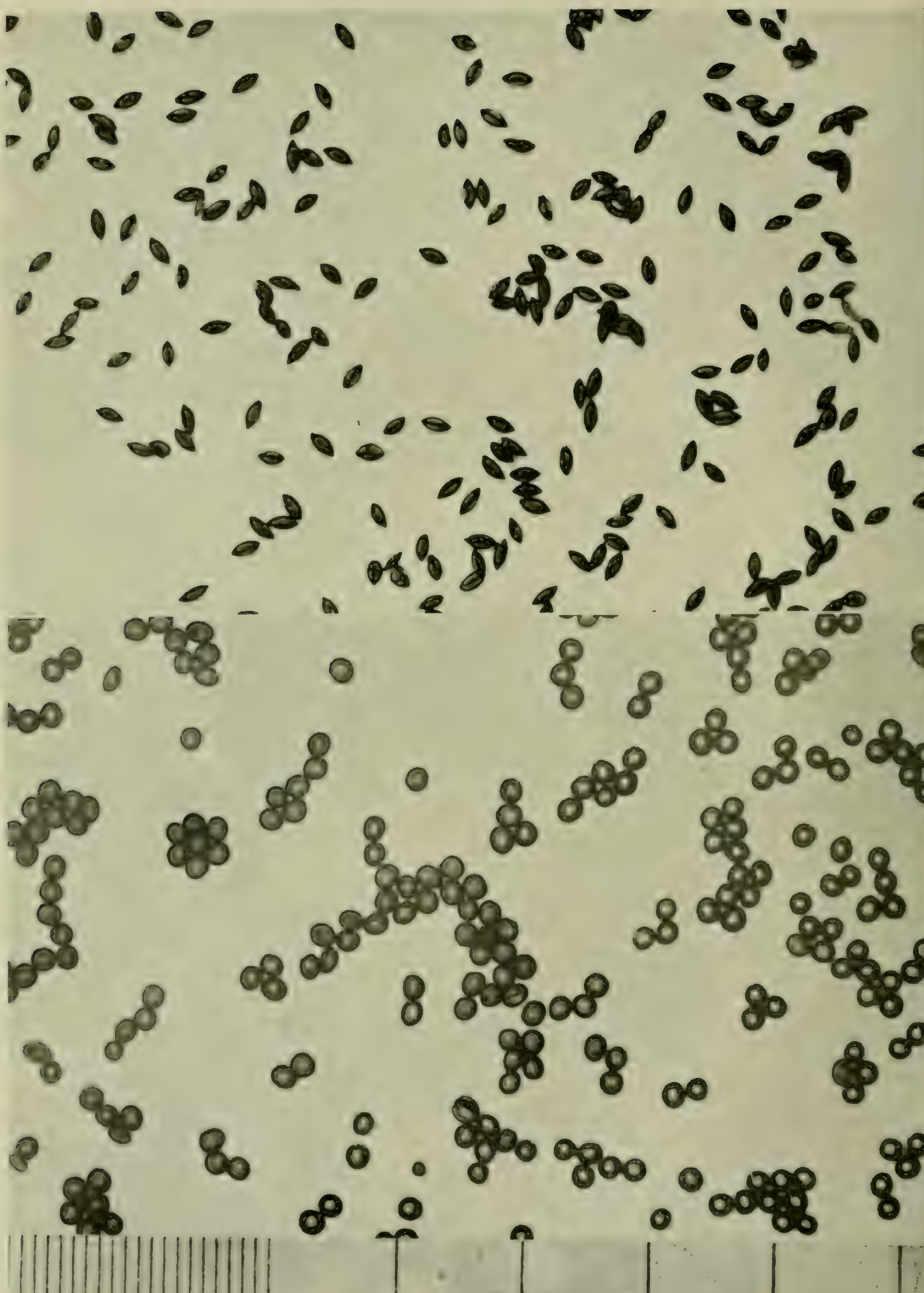
In this uncertain state the knowledge of sexuality in plants was destined to rest for 20 centuries, waiting for the experimental genius of Camerarius to give a conclusive answer to the question raised by the Assyrian and Greek gardeners and answered wrongly by Theophrastus. The English physician Grew (1676) did, it is true, accept and expand the suggestion of Sir Thomas

[2] The dates in parentheses throughout this paper indicate the time each discovery was published and also refer directly to the papers listed in the bibliography appended to this paper as published in *Science*.



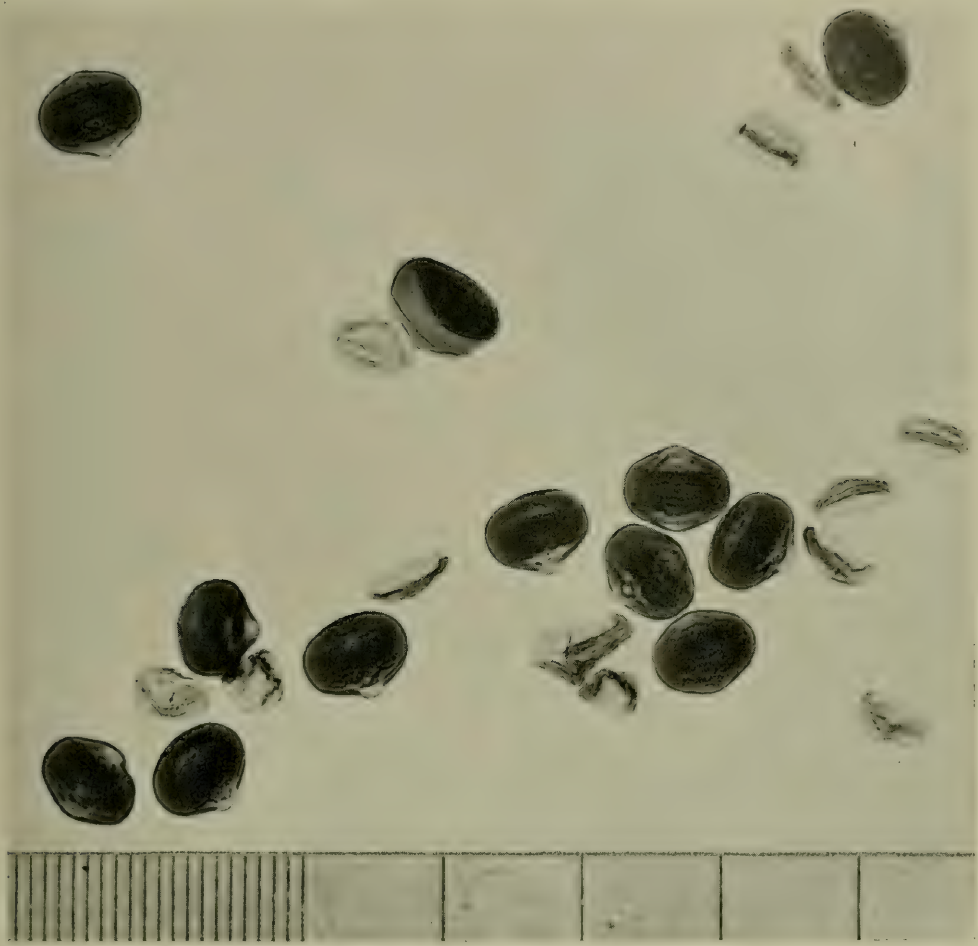
FLOWERS OF THE DATE PALM

On the left is a fragment of the female inflorescence, the short stigma being surmounted by a round ovary without any showy petals. On the right is a sprig of the more conspicuous male or pollen-bearing flower. It is branches of the male inflorescence like this that the date planter ties in the center of each female inflorescence, in order to ensure his crop of dates, which would be worthless unless pollinated. Photograph (much enlarged) from W. T. Swingle, Bulletin no. 53, U. S. D. A. Bureau of Plant Industry. (Fig. 2.)



EFFECT OF MOISTURE ON POLLEN GRAINS

Pollen of *Phoenix canariensis*, a species very closely related to the date palm, photographed at Gainesville, Florida, by John Belling, in October, 1914. The upper photograph shows the dry pollen as it leaves the anthers of the male flower. The microscope slide was then breathed on and another exposure made without shifting any part of the apparatus, the result being shown in the lower photograph. Scale at the bottom is in tenths and hundredths of a millimeter. (Fig. 3.)



FERTILE AND STERILE POLLEN GRAINS

Pollen of the first generation hybrid of the Florida Velvet bean (*Stizolobium deeringianum*) and the China bean (*S. niveum* var.). In this as in many other crosses of distinct species of plants, half the pollen is sterile and half the ovules aborted. Scale in tenths and hundredths of millimeters. Photograph by John Belling, Gainesville, Fla. (Fig. 4.)

Millington that the stamens serve as the male organs of the plant. Thus Grew concludes (p. 173) that when the anther opens the "globulets in the thecae act as vegetable sperm which falls upon the seed-case or womb and touches it with prolific virtue." But this guess, though it proved correct in the main point, was still a guess, and not supported by any critical evidence so far as recorded by Grew. The only adequate evidence that could be obtained on this question, while microscopes and technique were still so imperfect, was experimental evidence. This kind of proof was first given, some 20 years after Grew's work, by Rudolph Jakob Camerarius, of Tübingen. Camerarius fully appreciated the presence of a real problem here. He also had the genius to see that the philosophical attempts of many of his immediate predecessors, to discover its solution entirely in their own inner consciousnesses, were futile. With the insight of a modern experimenter Camerarius put the question to the plants themselves. The results of his experiments, as reported in the

famous letter of 1694 to Professor Valentin, of Giessen, were clear and conclusive. After noting that aborted seeds were produced by isolated—and therefore unpollinated—female plants of *Mercurialis*, and of the mulberry; by castrated plants of the castor bean; and by plants of Indian corn from which he had removed the stigmas, Camerarius gives his interpretation of these phenomena. He says (Ostwald "Klassiker," p. 25):

"In the vegetable kingdom there is accomplished no reproduction by seeds, that most perfect gift of nature, and the usual means of perpetuating the species, unless the previously appearing apices of the flower have already prepared the plant therefor. It appears reasonable to attribute to these anthers a nobler name and the office of male sexual organs."

In the seventy years after Camerarius had proved in this way the existence of two sexes, and the fertilizing function of the pollen in plants, little advance was made. Bradley, of London, Gleditsch, of Berlin, and Governor Logan, of Pennsylvania, confirmed parts of Camerarius's work, and the great Linnæus accepted the conception of the stamens and pistils as sexual organs as clearly proven, *not*, be it noted, *by the results of Camerarius's experiments* but by "*the nature of plants*."

KOELREUTER'S HYBRIDS.

In 1761 J. G. Koelreuter, of Carlsruhe, published an account of the first systematic attempt that had been made, with either plants or animals, to produce and carefully study artificial hybrids. In his work with hybrid tobaccos, he demonstrated that characters from both parents are often associated in a single offspring. He thus not only completed Camerarius's work, but also, by showing that the male parent participates in the makeup of the offspring, he helped materially to break down the "emboîtement theory" of Christian Wolff, which assumed that the embryo came entirely from the egg, and that its characters could not be influenced by the male parent. It is true that Koelreuter was mistaken in believing that fertilization is accomplished by the mingling of the oil on the pollen grain with the secretion of the stigma to form a mixed fluid, which he supposed then penetrated to the ovule. Nevertheless, his conception of the mingling of two substances was a move with the proper trend.

Koelreuter also demonstrated that in nature the pollen necessary to fertilization is often brought to the stigma by insects. He thus opened up a field of research which was cultivated with such splendid effect by Konrad Sprengel thirty years later, and by Darwin, Müller and others a century afterward.

In spite of the absolutely conclusive work of Camerarius, Koelreuter and Sprengel on the sexuality of plants, their conclusions were often rejected during the first half of the nineteenth century. Certain devotees of the nature philosophy, for example, occupied themselves either in proving over again, after Cesalpino, that plants can not be sexual, *because of their nature*, or in trying, by ill-conceived, and carelessly performed "experiments," to prove the conclusions of Camerarius and Koelreuter erroneous. These objectors were finally silenced, however, when Gaertner, in 1849, published the results of such a large number of well-checked experiments, entirely confirming the works of Camerarius, Koelreuter and Sprengel, that no thinking botanist has since doubted the occurrence in flowering plants of a sexuality essentially identical with that found in animals.

DISCOVERY OF THE POLLEN TUBE

During the opening years of the nineteenth century a number of botanists, who believed in the sexuality of plants, tried to discover by the aid of the microscope just how fertilization is effected. Most botanists of the day believed the pollen grain burst on the stigma, and that its granular contents found a way through the style to the ovary. An entirely new aspect of the problem of fertilization was opened up, however, when in 1823 Amici, of Modena, saw on the stigma of *Portulacca* young pollen tubes arising from the pollen grains. Seven years later he

followed these tubes through the style to the micropyle of the ovule. At about this time also, Jakob Matthias Schleiden (1838) took up the study of this same problem. He was a man of vigorous intellect and great versatility, who sometimes misinterpreted what he saw, but who proved a most stimulating opponent to a number of other workers who did observe accurately. After denying Robert Brown's assertion that the pollen tubes of the orchids arise in the ovary, Schleiden proceeded to describe and figure the pollen tube as penetrating not merely the style and then the micropyle, but even far into the embryo sac itself.

Here, as he says in his Grundzüge (II., p. 373):

"The end of the pollen tube soon swells, either in such a way that the vesicle arising in it fills the whole cavity of the portion of the tube within the embryo sac, or there is left, between the apex of the embryo sac and the embryonal vesicle of the tube, a long or a short cylindrical portion of the latter, the suspensor."

He thus regarded the embryo sac as a sort of hatching place for the embryo, which he thought formed from the end of the pollen tube. This idea of the origin of the embryo really denied the occurrence of any actual sexual process, and made the pollen the mother of the embryo.

ORIGIN OF EMBRYO.

In 1846, however, the error of this conception was clearly demonstrated by Amici, who showed that the embryo of the orchids arises from an egg which is alreadly present in the embryo sac when the pollen tube reaches it. It is this pre-existing egg, according to Amici, that is stimulated to form the embryo by the presence near it of the pollen tube. This view was confidently supported by Mohl (1847) and Hofmeister (1847) in the following year, and the controversy with Schleiden became even more spirited. As Mohl afterward wrote (1863), men were "led astray by their previous conceptions to believe they saw what they could not have seen." The dispute even approached the acrimonious, as when Schleiden (1843) says of one worker's figures,

STAMENS AND PISTIL OF TOBACCO FLOWER

In the center rises the tall stigma with its glossy, knob-like end, the pistil. About it stand five stamens, the anthers of which have already burst open and released the light yellow grains of pollen, which show in the photograph as a brilliant white. Photograph highly enlarged. (Fig. 5.)

MALE FLOWER OF MAIZE

The corn tassel is made up of many slender branches of small flowers, each with a pair of light yellow stamens hung on very slender filaments. From these stamens, half a dozen of which are seen extruded in the photograph, the pollen is dusted by the wind on the corn silk protruding from the husk at some point on the stalk below. This silk consists of long, slender stigmas (female); a pollen grain falls on the end of each one of these and must grow down the whole length of the silk to reach its own particular ovule on the ear, which it fertilizes to produce a grain of corn. Photograph highly enlarged. (Fig. 6.)

"Solche Präparate sind ohne Zweifel aus den Kopf gezeichnet."

Hofmeister, from the beginning of his study of fertilization in seed plants, had sought in the pollen tube for some equivalent of the spermatozoids, those motile male cells of the mosses and ferns that had first been understood by Unger in 1837. He was unable, however, to do more than point out the mistake of earlier observers in regarding the starch grains of the pollen tube as spermatozoids, and to suggest the likelihood that these motile cells might be discovered in the gymnosperms, a prediction the fulfilment of which was realized by Ikeno and Webber 50 years later. In his study of pollen tubes Hofmeister demonstrated to his own satisfaction that the tube does not open in accomplishing fertilization. His view, which was the one current till 1884, was that the egg is stimulated to develop into the embryo by some substance that diffuses through the *imperforate* wall of the pollen tube.

DISCOVERY OF PROTOPLASMIC FUSION.

We come now to consider a series of discoveries of supreme importance in the investigating of the essential sexual process in plants. This is the period in which the problem that had baffled naturalists for twenty centuries was at last solved, at least in one most essential feature, by the demonstration of the occurrence at fertilization of a mingling of paternal and maternal substances.

It will not be without interest at this point to note the intellectual stimuli which led an unusual number of workers to investigate this phase of our problem.

In the first place, there were on record, and under discussion, at the middle of last century, the many puzzling observations of the "Spiralfaden," or animalculæ, as they were thought to be, that had been found arising from a number of plants. These motile, spiral filaments had been seen in a liverwort (*Fossombronia*) by Schmiedel (1747), in *Sphagnum* by Esenbeck (1822), in *Chara* by Bischoff (1828), and finally, on the fern prothallus by Naegeli (1844). Unger (1834-37) studied these bodies in

the mosses (*Sphagnum* and *Marchantia*) and declared his belief that they are not infusoria, but are the male fertilizing cells. At this time also the zoologists of the day were making the first detailed studies of the spermatozoa of animals. Barry (1844) had seen a spermatozoön within the egg of the rabbit; Leuckart (1849) saw them enter the frog's egg, and then, in 1851, Bischoff and Allen Thompson proved that fertilization is accomplished by the actual entrance of the spermatozoön into the egg. A no less important influence, in stimulating the botanical workers on the problem of fertilization, was the magnificent work of Hofmeister, on the reproductive structures of the mosses, ferns and conifers. By these splendid researches he had indicated to men of less insight, and less comprehensive imagination, just the points in the life cycles of plants where the critical phases of the reproductive process are to be sought.

The first step toward the demonstration of a union of two masses of living substance at fertilization resulted from the study of a group of plants in which sexuality had not hitherto been proven or even generally admitted—namely, the algæ. It had, however, long before been suggested in the case of *Spirogyra* by Hedwig (1798) and Vaucher (1803).

STUDY OF ALGÆ.

The algæ were in fact especially advantageous for the study of fertilization, since the development and behavior of the reproductive organs and cells could, without elaborate preparation, be readily seen under the microscope, and often followed through in living material. Thus Thuret, in 1853, for the first time saw the active sperms attached to the egg of *Fucus*, and in 1854 proved experimentally that only eggs to which spermatozoids have had access will germinate. He thus demonstrated in this alga the correctness of Unger's unsubstantiated surmise (1837) that the spermatozoids are the male fertilizing cells. In *Œdogonium*, Pringsheim, in 1856 (p. 9), watched the spermatozoid push into the receptive tip of the living egg and saw the characteristic oöspore wall formed in consequence. This, except for the less satisfactory observations made on *Vaucheria* by the same worker a year previous, is the first case recorded of the observation of the actual union of male and female cells in any plant. Such a union of the protoplasmic masses of the two sexual cells was soon shown to be a characteristic feature of fertilization in a number of algæ. Thus de Bary saw it in *Spirogyra* (1858), and Pringsheim (1869) repeatedly observed the gradual fusion of the motile gametes of *Pandorina*. It was nearly 30 years later, however, that this phase of fertilization was first seen in seed-plants by Goroschankin and Strasburger.

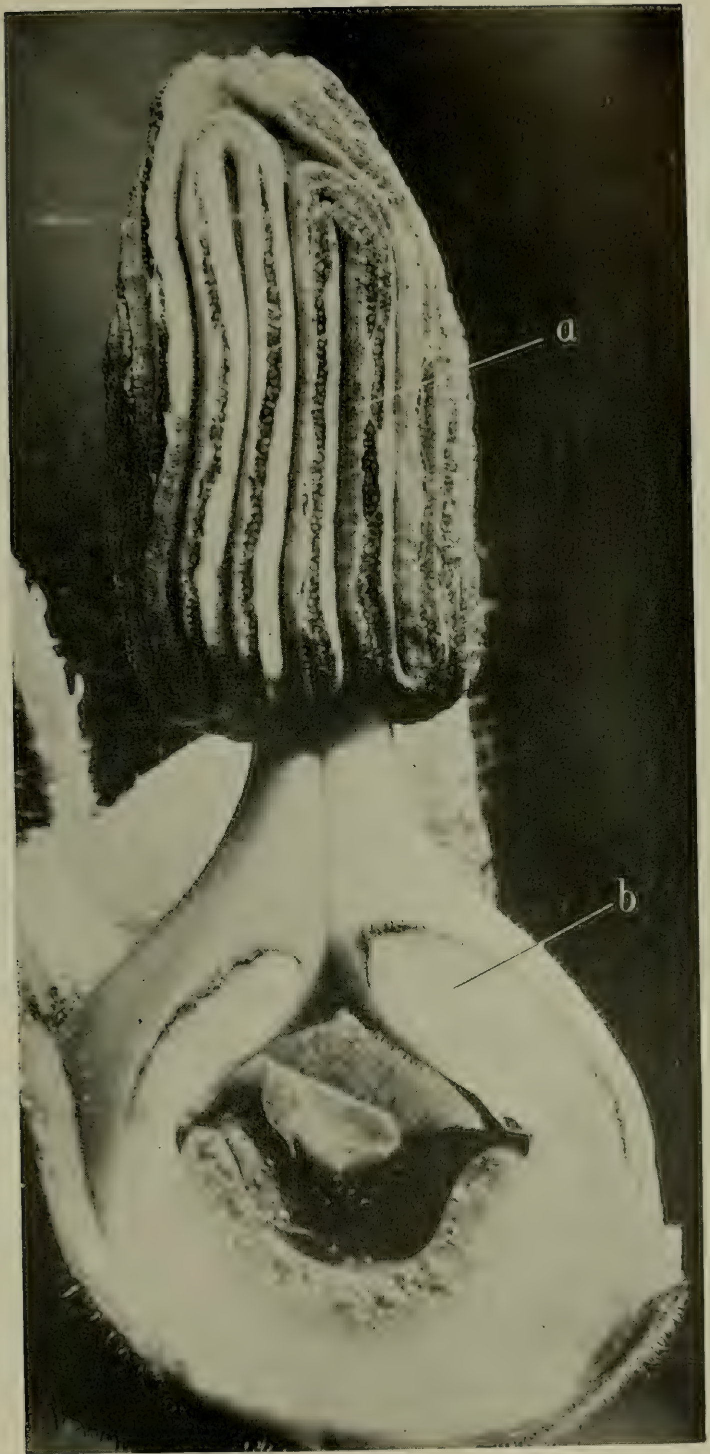
LACK OF PROPER METHODS.

The workers on this problem were on the lookout for further details of the process of fusion, and even knew rather definitely what they were looking for, but failed to discover it from lack of proper methods of preparation of material. Thus, *e. g.*, Strasburger, in 1877, carefully studied the process of conjugation in *Spirogyra* and found that "Hautschicht fuses with Hautschicht, Kernplasma with Kernplasma"—"The chlorophyll bands unite by their ends"—and then goes on to say of the feature that evidently interested him most, "the cell nuclei of both cells, however, become dissolved; the copulation product is without a nucleus." Two years later, Schmitz (1879), when studying hematoxylin-stained material of this alga, was more fortunate. He saw the two nuclei in the zygote, as he says, "approach nearer and nearer, come into contact and finally fuse to a single nucleus." This observation by Schmitz is an important one, for in it we have the first clear statement that the nucleus of the male cell passes over intact to the female cell, there to fuse with the female nucleus.

Strasburger had, it is true, seen a second nucleus fusing with that of the egg in the archegonia of *Picea* and *Pinus* in 1877. He did not, however, really know the source of this second nucleus, though he suspected some relation to those that are present earlier in the tip of the pollen tube. These tube nuclei

THE MALE PUMPKIN FLOWER

At the left the brilliant yellow blossom is shown slightly enlarged and cut open, with one side of its broad trumpet let down. At the right, much more enlarged, is the anther column covered with dark golden yellow pollen grains, some of which have already fallen and may be seen sticking to the white column. The pumpkin is monoecious—that is, male and female organs are borne in separate flowers, but on the same plant; while the date palm (fig. 2) is dioecious, the male and female flowers being borne on separate plants, and the tobacco (fig. 5) is hermaphrodite, the staminate (male) and pistillate (female) organs being united in the same flower. (Fig. 7.)



PUMPKIN POLLEN PRODUCTION

The male flower, stripped of its petals and highly enlarged. The anthers are designated by *a* and the filaments (combined into a column) by *b*. The anthers are just bursting and the narrow, labyrinthine slits reveal the pollen grains inside. The swollen base of the stamens is hollow and has been cut open so that one can see through it, in order to make its construction clear. (Fig. 8.)

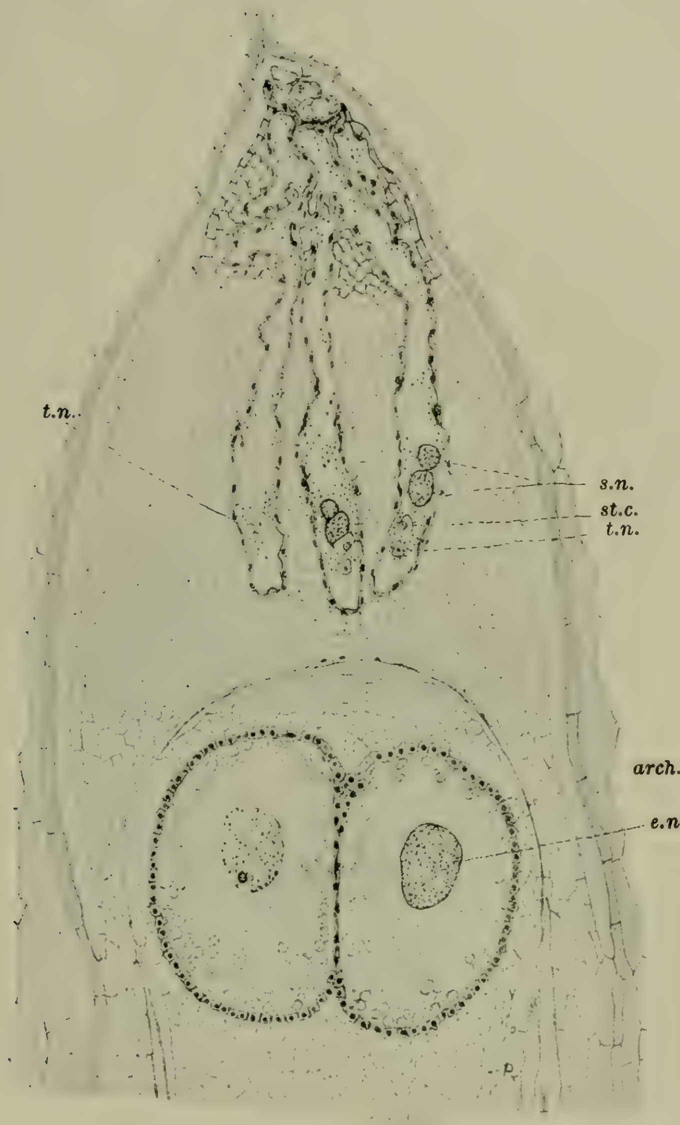
STIGMA OF A PUMPKIN FLOWER

It is upon the rough, sticky surface of this irregular body that the male pollen grains fall and germinate. Each one sends out a tube which grows down into the tissue of the stigma (see the following figure) and finally reaches the ovary which lies below. The nucleus of the pollen grain slips down this tube, comes in contact with one of the ovules in the ovary and unites with it, thus fertilizing it and permitting it to grow into a pumpkin seed. Photograph much enlarged. (Fig. 9.)

he says are dissolved just before fertilization, and then just after fertilization, to quote (1877):

"The male nucleus *formed from the contents of the pollen tube* is found now near the end of the tube, now near, or in contact with, the egg nucleus. . . . The protoplasmic contents of the pollen tube, I hold, passes through the (imperforate) tube-membrane in a diosmotic manner."

The fertilization of the gymnosperms, because of their large eggs, pollen tubes and nuclei, was at this time being studied by a number of workers. One of these, Goroschankin, in 1883, was able to demonstrate that in *Pinus pumilio* the pollen tube opens at the end, and that through this pore the two male cells pass bodily into the egg. Goroschankin's mistake, in supposing both male nuclei to fuse with the egg nucleus, was corrected by Strasburger the following year. The latter (1884) saw the same bodily exit of both male nuclei from the *open* pollen tube of *Picea*, but found only one male nucleus fusing with that of the egg. In the same publication Stras-



HOW THE POLLEN TUBES GROW

Vertical section of ovule of a pine, shortly before fertilization; magnified about 100 diameters. Three pollen tubes can be seen growing down from the micropyle, the narrow channel at the top by which they entered. *s.n.* is the sperm nucleus, *t.n.* the tube nucleus, *st. c.* a stalk-cell. There are two archegonia (*arch.*) or egg cells, each with its egg nucleus (*e.n.*). When a sperm nucleus from one of the pollen tubes finally reaches one of these egg nuclei, it will unite with and fertilize it, thus initiating the development of the seed. After Ferguson, *Life History of Pinus*, Washington, 1904. (Fig. 10.)

burger also records numerous instances in which he had been able to observe the same mode of escape of the contents of the pollen tube into the ripe embryo sac in angiosperms. At last, as Strasburger puts it, in discussing fertilization in the conifers:

"The most important morphological facts are clear. It is established that the male nucleus that copulates with the egg nucleus, passes *as such* out of the pollen tube into the egg."

Thus, finally, was the actual material contribution of both parents to the embryo of the seed plants first seen. This was just two centuries, lacking a decade, after Camerarius (1694) had proven that the presence of pollen on the stigma is indispensable to seed-formation. One chief reason why this important problem so long baffled all investigators was the lack of proper methods of preparing material for study. The older method of studying unfixed and unstained sections had certain advantages, it is true. The sequence of developmental stages was often determined with certainty by actually following their succession in living material under the microscope, and there was less cause also for dispute about artifacts. But structures of the same refractive qualities were not readily distinguished in such sections. As Strasburger himself says (1884, p. 18):

"The negative results of my earlier studies and of those of Elfving were due to the lack of a method which permitted the nuclei to be distinguished in the strongly refractive contents of the pollen tube up to the moment of fertilization."

That these studies of 1884 were successful was largely due to the use of material fixed in .5% acetic acid, 1% osmic acid or absolute alcohol, and stained in borax carmine, hematoxylin or iodine green.

The extreme significance of the fact that those most highly organized portions of the cell substance—the nuclei—were so prominent in the process of fertilization was at once appreciated by Strasburger, who in 1884 announced the following general conclusions as the outcome of his consideration of the phenomena observed:

"(1) The fertilization process depends upon the copulation with the egg nucleus of the male nucleus that is brought into the egg, which is in accord with the view clearly expressed by O. Hertwig. (2) The cytoplasm is not concerned in the process of fertilization. (3) The sperm nucleus like the egg nucleus is a true cell nucleus."

In the years since 1884 the nuclei have been found to be the structures chiefly concerned in fertilization, whenever such a process occurs. Among the earlier observations of this nuclear union at fertilization in each of the great groups are the following, named in the order of discovery: It was seen in *Pilularia* (Campbell, 1888), in *Riella* (Kruch, 1891), in *Œdogonium* (Klebahn, 1892), in the plant rusts (Dangeard and Sapin-Trouffy, 1893), in the toad-stools (Wager, 1893), in the red alga *Nemalion* (Wille, 1894), in *Sphærotheca* (Harper, 1895), in the rockweed, *Fucus* (Farmer and Williams, 1896). Finally Zederbauer (1904) reported it for the Peridineæ, and Jahn (1907), Olive (1907) and Kraenzlin (1907) made it out in the myxomycetes.

The observations just referred to, and many others on plants in all groups, warrant the general application of Strasburger's conclusion that a nuclear union is the characteristic feature of every sexual process. The few cases where the male cytoplasm seems more prominent than usual, as in the three conifers studied by Coker (1903), Coulter and Land (1905) and Nichols (1910), can not yet be said to have rendered it very probable that this cytoplasm plays a primary part as an inheritance carrier.

PREPOTENCY

A Quality Belonging to Characters Rather Than Individuals—Something More Than a Result of Inbreeding—Linkage or Coupling of Separate Factors in Heredity Explains Observed Prepotency, and the Difference Between "Breeders of Breeders" and "Breeders of Performers."

Edward N. Wentworth
Professor of Animal Breeding, Kansas State Agricultural College, Manhattan, Kans.

According to the opinion of leading live stock men, the chief essential to success in breeding is the possession of prepotent breeding animals (particularly sires). Very few of these men will attempt to explain what this prepotency is and fewer still can give more than an extremely fragmentary idea. Yet the fact is self-evident to the student of pedigrees that there are marked differences among breeding animals, since only 3 to 5% of the breeding stock existing a few generations back is represented in the tables of ancestry of the present-day individuals.

Just what factors are responsible for this condition? Without doubt, fashion and advertising play an important part in determining the blood lines that shall survive, but the breeder in final analysis is a business man demanding performance, and as has been shown in numerous studies,[1] there is actual difference in the breeding power of individuals. Davenport in his "Principles of Breeding" sums up a distinction common among practical breeders when he points out "breeders of breeders" and "breeders of performers," or those that transmit performance through more than one generation and those that simply confer the good qualities upon their offspring.

It has been customary in defining prepotency to state the manner in which the breeder thinks it occurs. According to popular idea, prepotency depends upon the presence of a "high percentage of blood" of some particular individual. The means by which prepotency is brought about is by a supposed narrowing of the bloodlines, either through inbreeding, linebreeding, or some form of pedigree selection. Prepotency is assumed to be the result of a cumulative effect of ancestry. In correspondence conducted by the writer a few years ago to obtain prevalent ideas on the nature of prepotency, the following communication was received from Dean Eugene Davenport of the University of Illinois. It is of interest in that it very clearly expresses the popular idea on the subject.

"Prepotency, of course, is a corollary of the law of ancestral heredity. That parent that has behind him the largest mass of back ancestry selected to the same characters, will, of course, be prepotent. If you take the series of fractions, ½, ¼, ⅛, etc., and divide them by 2, representing the contribution of the sire and dam, you will obtain the possibilities of each expressed in fractional form so far as prepotency is concerned. . . . If, now, all the individuals represented by these fractions have been selected to the same standard, then, of course, the sire himself backed by his ancestors will control one-half of the possibilities of the offspring, regardless of what the female will be. Of course this same would be true for the female under like conditions. This, it seems to me, *is the essence of prepotency, and it is all there is of it.*"[2]

[1] "Distribution of Prepotency," Francis Galton. Nature LVIII, 246-247. "Principles of Breeding," Eugene Davenport. Pp. 551-567. "Prepotency of Different Plants," W. W. Tracy. Proc. Soc. Prom. Agr. Sci. 1900, pp. 57-59. "Result of Selecting Fluctuating Variations," F. M. Surface, Conf. Internationale Génétique 1911, pp. 221-256.

[2] The italics are mine.

While this idea is widely held by animal husbandmen, the man who has conducted genetic experiments and watched the segregation of individual factors cannot help but feel that the conception is manifestly outside of the facts. The behavior of hereditary characters as though controlled by unit factors in the germ plasm leaves no room for a cumulative effect of ancestry (unless the increased opportunities tc bring about homozygosis through selection in hereditarily limited stock be thus considered).

NATURE OF THE GERM PLASM.

Even the parent himself has no effect on his progeny in an hereditary way, as inheritance does not really consist in the passing on of characters from one generation to the next. The similar characters of parent and progeny develop because both parent and progeny arise from qualitatively the same germ-plasm (as far as the particular characters are concerned). When one mixes lime chloride and sulphuric acid he will obtain lime sulphate and muriatic acid. These are the end products of the reaction. If he sets apart a portion of the lime chloride and sulphuric acid the first day and a few days later mixes them, he will get the same result. The results of the first day have no effect on the results of the later day. When the germ cell of the animal begins development it corresponds to the first chemicals, the developed body to the end-product of the reaction. Characters that are alike in parent and offspring arise because they come from similar origin, but the body, an end-product of development, no more affects the germ cells that produce the progeny, than the end-products of the chemical reaction affected the reaction of the later day. This shows by analogy how far outside the facts of inheritance the conception of a cumulative ancestry lies.

To indicate the principal difference between the prepotent and non-prepotent sire, the roan Belgian referred to by the writer in a previous paper, that sired only red roan colts (256 in number) from various colors of mares may be compared to another roan Belgian therein mentioned that produced about half roan colts and the other half grays, bays, browns, blacks and chestnuts. Obviously the first horse was the more prepotent of the two. He must have transmitted red roan in every germ cell. To do this, he must have been homozygous or pure for the dominant characters of roan pattern and bay color; that is, he must have received both roan and bay from sire and from dam. While there is no way of exactly determining what was transmitted in the germ cell, the fact that both parents were bay (red) roans[3] and that only bay roan colts were produced would show that there was only one chance out of approximately 18,062,500,000,000,000,000 that the assumption is wrong.

The second horse, on the other hand, was sired by a blue roan stallion out of a bay mare. This indicates at once that he cannot be homozygous for roan since he received it from only one parent, nor could he be pure for bay since it came only from the dam. Yet he sired about 50% of red roans and blue roans, a performance which some breeders might also consider prepotent.

PREPOTENCY AND PURE BREEDING.

This indicates the first essential of prepotency, homozygosis in a dominant character. Of course, the breeder believes that prepotency is a property of the individual and not of the character. But in almost every instance the idea of prepotency is based on some superficial and striking character like color, and it is assumed that since this character appears with fair uniformity, the rest of the characters must appear also. As a matter of fact, it is highly improbable that there ever occurred the ideally prepotent animal described by the breeder; that is, one which is able to impress most of his characters upon his progeny in spite of the females to which he is mated. The livestock man reads with interest of that great line of Clydesdale sires from Darnley down through Topgallant, Sir Everard, the

[3] There are two classes of red roans corresponding to bays and chestnuts, but each carrying the roan pattern.

long lived and redoubtable Baron's Pride, the $47,500 Baron o' Buchlyvie, and the sensational five-year-old sire, Dunure Footprint; each a son of the animal preceding and, with the exception of Topgallant, each a distinct step in advance of his progenitor, as far as siring prize winners is concerned. Here is an exceptionally prepotent line, because all but Topgallant were the leading sires of Scotland during their tenure in stud. Yet even these great horses begot a percentage of failures that is startlingly large, even though smaller than that of any other line of sires in any breed. Prepotency is never a property of the individual, but belongs to a certain few characters that are part of the hereditary makeup of the individual, and their condition as to homozygosis or heterozygosis is the entire determining factor. The degree by which one animal is more "strongly bred" for a character than another animal is this wide degree of purity or hybridity.

EXISTS IN BOTH SEXES.

Many breeders deny the existence of prepotency in the female, and consider it entirely a property of the male sex. This belief has come about as a result of two conditions. Since in all domestic breeds polygamy is practiced, it is obvious that a smaller number of males is required than females. This admits of a more stringent selection in one sex than in the other, and increases the chances of the male's having both greater numbers of homozygous characters and also more desirable combinations of characters. Furthermore, in uniparous races, such as the horse and ox (the species in which the art of animal breeding has largely been developed), there is only one individual in a season that may be compared to a female, while numerous individuals occur that may resemble the male. Where there is much diversity among the females, the fact that only one out of the season's progeny may show resemblance to any particular female, while numbers may partake of the characters borne by the sire, is bound to over-emphasize the importance of the male as far as hereditary influence is concerned.

Thus far the discussion has applied only to simple qualitative characters that depend on relatively few and easily recognizable factors. When one approaches quantitative characters such as size, vigor, etc., from which dominance is probably absent, the problem becomes more complex. It seems very doubtful if the principle differs here, but the presence of larger numbers of factors or of factors for greater development must be assumed to take the place of the dominant factors already discussed. At least the writer does not believe that there are two schemes of heredity involved in inheritance, and since one has been found to hold in the qualitative characters, and since the data assembled on quantitative characters seem to follow the same system as far as they have been investigated, it is no more than logical to make the preceding assumption.

Another cause of prepotency in quantitative characters may arise where the male bears one factor necessary to link up the factors in the female to produce the desired character. Thus, in the ordinary white mouse, the base for pigment production, a factor denoted by C, is lacking. In one variety of Japanese waltzing mouse, white with faint yellow marks, Darbishire found the factors for agouti, black and chocolate missing and the yellow diminished quantitatively. Yet the progeny of the cross were agouti, because the Japanese variety supplied the color base which the white mice lacked. While the prepotent animal usually breeds true for its character, this extreme case is interesting because it shows how one individual may supply the one factor necessary to a relatively uniform somatic expression. Breed history records many prepotent sires that bred better than themselves. Perhaps the trotter George Wilkes and the Shorthorn Champion of England would fall in this class.

LINKAGE OF CHARACTERS.

Emphasis has been laid on the usual custom of declaring prepotency on the

basis of some striking superficial character. Attention was directed to the fact that it is probable in the main that this character is transmitted alone and independently of other characters, yet such need not by any means be the case, since the phenomenon of linkage and coupling assures us of a mechanism whereby totally unrelated characters physiologically may be part of one hereditary complex. Thus T. H. Morgan and his associates have demonstrated in the pomace-fly, Drosophila, the tendency of miniature wings, yellow body, and white eyes to be grouped together, in segregating out of crosses with the normal fly that has the gray body, red eyes, and long wings. Many other combinaticns of similarly linked characters have also appeared in their work, some linked to sex as the characters just mentioned, and some uninfluenced by the sex determining factor. They have interpreted these results on the basis of the factors in the germ cells that produce these characters somatically, having practically a common locus (probably a chromosome). If such be the case in the domestic mammals, and there is no more reason for doubting it with them than with Drosophila, there is really a genetic foundation for the belief of the breeder that the superficial characters on which the degree of prepotency is determined also indicate the transmission of other characters, at least characters that find their origin at the same germ locus (chromosome).

As a result of this, one can see very clearly that the distinction between the "breeder of breeders" and the "breeder of performers" is almost entirely a question of character linkage, the "breeder of performers" ending his function when he has contributed a number of characters to his progeny, so distributed among different hereditary complexes that the segregations in germ cell formation separate the necessary interacting factors. The "breeder of breeders" must bear his factors that interact to produce performers in one hereditary complex only. The "breeder of performers" possibly has similar factors to the "breeder of breeders," but they are located in two or more complexes, thus permitting segregation and separation.

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Origin of Shetland Ponies

"The Making of the Shetland Pony" is discussed by J. Cossar Ewart as an appendix to "The Shetland Pony" by Charles and Anne Douglas (Edinburgh and London: W. Blackwood and Sons, 1913). He comes to the conclusion that "Shetland ponies are mainly descended from the 'small and fleet' race yoked to the chariots of the Caledonians at the battle of Mons Graupius. This ancient race, again, was probably to begin with a blend of the slender-limbed, Arab-like ponies of the Swiss lake-dwellers, and of a thick-set race of the elephant-bed [a fossil deposit near Brighton] type." Their small size he explains as follows: "If Shetland ponies have not sprung from a small wild pigmy race, it may be safely asserted that their small size is mainly due to isolation in small areas where they were forced to shift for themselves under, as a rule, extremely unfavourable conditions."

LIVE-STOCK GENETICS

Review of the Work in Experimental Animal Breeding, Now Under Way at the Various Agricultural Experiment Stations in the United States.

THE RESEARCH COMMITTEE ON ANIMAL BREEDING

BREEDING domesticated animals for research in genetics is restricted by the great expense it involves, the long generations, and the small number of individuals produced at a generation, not to mention other difficulties. Genetists have therefore used plants for experiment, wherever it appeared that a problem could be solved equally well in either medium. Furthermore, a good many lines of experimental animal breeding do not lend themselves to any immediate end of economic importance. For these reasons, the agricultural experiment stations in the United States have gone into this line of research only to a limited extent, and some of the work they have done is little known as compared with the purely experimental and more fully reported investigations made at universities and other institutions.

In order that the contribution which the experiment stations are making to genetics may be appreciated, the Research Committee on Animal Breeding of the American Genetic Association presents the following report, reviewing part of their work. No doubt it will be found that some important lines of investigation have been omitted; and to save space the committee has ignored many breeding projects, some of them on a large scale, which have for their purpose the improvement of a breed by the same method used by farmers and ranchmen, and which are likely to throw little, if any, new light on the laws of heredity. Experiments of this nature often take up most of the attention of genetists who work with live-stock at the experiment stations, and their economic importance is very great, but a review of them was thought to be of little interest in this Journal.

Probably no station has made more contributions to the theory of animal breeding than has that of Maine, whose department of biology, organized in 1907, is directed by Raymond Pearl, and whose staff includes 10 associates and assistants and a number of graduate students. To date 72 papers have appeared from this laboratory, most of them dealing with some phase of genetics. Among the problems now under investigation is the important one of the inheritance of fecundity in poultry, to which some notable contributions have already been made. "Two definite and clear-cut results have already come to light. These are:

"First: that the record of egg production or fecundity of a hen is not of itself a criterion of any value whatsoever from which to predict the probable egg production of her female progeny. An analysis of the records of production of large numbers of birds shows beyond any possibility of doubt that, in general, there is no correlation between the egg production of individuals and either their ancestors or their progeny.

"Second: that, notwithstanding the fact just mentioned, fecundity is, in some manner or other, inherited in the domestic fowl. This must clearly be so, to mention but a single reason, because it has been possible to isolate and propagate from a mixed flock 'pedigree lines' or strains of birds which breed true, generation after generation, to definite degrees of fecundity."

This interesting conclusion was reached after the failure of a long-continued experiment to increase the egg-production of hens by simple "mass selection." As to the real solution, Pearl thinks the capacity for high egg production is inherited through the sire rather than the dam, experiments having shown that high egg producing hens

and low ones produced daughters having the same grade of egg productivity, when mated to the same cock. If this be the true result, it is obvious that poultrymen should seek above all to secure cocks from strains noted for their high egg records and obtain hens from these cocks for high egg production. Pearl further attributes the fecundity of the breeds of fowl studied by him to three distinct Mendelian factors, one of which is sex-linked. The study of sex-linked characters—that is characters which are transmitted through the male to half of his grandsons, or through the female to her sons, etc., is being carried on at the station along many lines.

INBREEDING.

Considerable theoretical contributions to the subject of inbreeding have been made from this station, one of them being a mathematical method of measuring the intensity of inbreeding. The practical breeder has been content to say, in measuring the amount of inbreeding of a descendant of the Shorthorn bull Ringmaster, let us suppose, that a certain calf was "seven-eighths Ringmaster blood." This statement, however, does not give any definite idea of the pedigree of the calf; European zootechnists therefore evolved the count of so-called "free generations" which is a good practical measurement and easily understood. If, for example, Ringmaster appeared three generations back in the calf's male line, and two generations back in the line through the dam, there are two free generations on the male side and one on the female; adding these together, the calf is said to have three free generations, in respect to Ringmaster. It has been found, to carry the matter a step further, that most winning English racehorses during the last half century have had five free generations; prior to that, four free generations was the rule. When there are no free generations, Thoroughbreds are likely to be deficient in vigor (a result commonly attributed to high inbreeding), when there are more than five free generations, they fail because their speed (the product largely of inbreeding) has been swamped by outcrossing, or lost by reversion.

Pearl proposes to measure the degree of inbreeding of any individual algebraically, by calculating the possible number of ancestors in previous generations and comparing this number with the number actually found in the animal's pedigree. By the use of some such accurate measurement as this (which is described and illustrated in bulletins 215 and 218 of the Maine station) a further study of inbreeding will be much more practicable, and should throw light on one of the most fundamental and debated problems of practical genetics.

That a certain amount of inbreeding is advantageous in the maintenance of blooded stock is now generally admitted; that an excessive amount is dangerous is also pretty widely believed. Pearl, like a great many other geneticists, thinks the question of degree, *in itself*, is of secondary importance, the real question being the quality of the animals inbred. The Maine station has issued the following counsel to breeders:

"That a mating of such close relatives [as brother and sister or parent and offspring] will surely result in disaster is one of the carefully nursed superstitions of breeding, which has often been exploded but will doubtless always be with us. It may be said that all the evidence which may be gleaned from the experience of stock breeders indicates that the results which follow inbreeding depend entirely on the nature of the individuals bred. If one inbreeds weak animals, lacking in constitutional vigor, and carrying the determinants of undesirable qualities in their germ cells, the offspring resulting from such a mating will undoubtedly be more nearly worthless than their parents. If, on the other hand, one inbreeds in the same way strong and vigorous animals, high in vitality and carrying the germinal determiners of desirable qualities, there may be expected a corresponding intensification of these qualities in the offspring. The time has come when a vigorous protest should be made against the indiscriminating condemnation of inbreeding. It should be clearly recog-

SIRE OF A NEW BREED

Pure-bred fat-rumped ram from Siberia, owned by the South Dakota Agricultural Experiment Station, and expected to aid in the production of a type of sheep that will be able to withstand the severe winters of that state successfully. The Fatrump breeds of Siberia are noted for their hardiness: when the food supply is entirely cut off by snow, they are able to subsist for some time on the fat stored in the rump. It is hoped that this valuable characteristic can be retained in the hybrids bred in the United States. (Fig. 11.)

nized that if the experience of stockbreeders extending throughout the world, and as far back as trustworthy data are available, means anything at all it plainly indicates that some degree of inbreeding is *essential* to the attainment of the highest degree of success in the breeding of animals, poultry forming no exception to this rule."[1]

STUDIES OF CATTLE.

At the Massachusetts station an attempt is being made to work out a comprehensive correlation between Dairy Form of cattle (as called for in the show ring, and in text books) and butter-fat and milk production. This work is necessarily statistical and includes complete measurements of a large number of cows on which production records have been maintained for three or more years. The object is twofold: to seek a clue to the mode of inheritance of milk and butter-fat production in dairy cattle, and to determine whether the present standards of judging dairy cattle are really based on sound genetic knowledge. Studies in the inheritance of coat color in mammals are also under way, and furnish material for an incidental inves-

[1] "Of course," Pearl notes, "if the term *inbreeding* makes too violent a strain upon anyone's intellectual, moral or merely human prejudices, there is no objection to his using for the practice the term *line-breeding*, or some other even milder designation."

tigation of the effect of inbreeding on fertility.

At the Massachusetts station the poultry department is using both fowls and ducks in an endeavor to get as much genetic information as possible, the principal point under consideration being the inheritance of fecundity. An investigation is also being carried out on the inheritance of hatching power of eggs, of comb form, color and color patterns, shank feathering and rate of growth. Some of the latter researches parallel those that have been made by Bateson, Davenport and other investigators, the Massachusetts station desiring to confirm or apply their results, and to find satisfactory interpretations for the new facts observed.

Influence of management and feeding on vigor of germ in hen's eggs has been investigated in West Virginia. The data already in hand indicate that chicks are less vigorous when hatched from eggs laid by hens which have been laying heavily for a long time.

A study of inheritance in the honey bee has been pursued in Texas for several years.

The Porto Rico station is improving native cattle by crosses with zebu hybrids brought from Texas.

As a result of hybridizing wild and tame cavies for past six years, the Illinois station has reached some interesting conclusions which have just been published by the Carnegie Institution of Washington[2] (publication no. 205). The investigators are convinced that the Mendelian mode of inheritance prevails for individual characters in species crosses in mammals in the same way as in variety crosses, contrary to what has sometimes been asserted. Many different characters have been studied and their mode of inheritance is reported in this paper. Fertility in the male hybrids seems to be a very complex character which segregates out in the Mendelian fashion. At present work of selection and hybridization is under way with mice and other small mammals. There has been room for plenty of more practical work, for over a million cows are kept for dairy purposes in Illinois, of which not more than 2% are purebred. The station has induced many breeders to add purebred bulls to their herds and is endeavoring to get as many cows as possible accurately tested, although at present only a fraction of 1% of the total number can show accurate records of production, kept either officially or privately. "It should be considered little less than a crime to use a scrub bull, or one whose dam has not produced 300 lbs. of butter fat in 365 days," the breeders are told, and they are gradually taking the advice to heart.

TO PRODUCE BROWN EGGS

By crossing suitable breeds, the Maryland station has undertaken to produce a breed of general utility fowl that will lay a white shelled egg. The superior market value of the white egg over that with a brown shell is well known; and although the preference seems to be wholly irrational, breeders must be prepared to meet the situation. Unfortunately the breeds that lay white eggs are, as a rule, small and ill adapted for marketing. It should be possible to transfer the capacity to produce white shelled eggs (which seems to be a Mendelian character) to a breed that will also make good "broilers." It is this task which the Maryland station has undertaken.

Heredity in sheep is being studied in New Hampshire, observations on the mode of inheritance in horns having already been published. In cattle, the polled condition seems to be a regular Mendelian dominant except that, according to Spillman, the dominance is not entirely complete in male heterozygotes. In sheep, the inheritance of horns does not follow the same rules, although it is thought by many students to follow an equally simple system. The New Hampshire station has worked principally with Merinos, and in order to interpret its data has postulated two "determiners" in the germ cell, the behavior of which differs in each sex, and has also postulated the presence of hypothetical "inhibitors," which further

[2] Most of the actual breeding, results of which are reported in this publication, was done at the Bussey Institution, Forest Hills, Mass.

complicate the explanation of its findings.

Crossing Tunisian sheep with native breeds, and with Shropshires, Oxfords, Hampshires and Rambouillets, has been under way for several years at the Arizona station. There are now more than 150 rams bred by the station, from one-half to one-eighth Tunis, in use in Arizona, which means that about 10,000 lambs containing Tunis blood are produced each year. They are not only particularly hardy and vigorous, but have proved of great value in eradicating Johnson grass (*Andropogon halepensis*) along the irrigating ditches.

MULE BREEDING.

The breeding of mules is being studied in Mississippi from almost every possible aspect. Influence of the type, size and quality of sire and dam respectively, on offspring are being watched, the fertility of the mule is being investigated in a search for that apparently more or less mythical "fertile mule" which is reported in live-stock publications at constant intervals, along with the equally mysterious "sheep-goat hybrid" for which every breeder has probably sought with interest at some time in his experience. Finally, the relative qualities of mules and hinnies are tested and measured.

The supposed existence of "racial poisons" is being submitted to rigorous scientific test in Wisconsin. It has long been admitted that certain poisons —as well as unfavorable conditions—to which a mother is exposed during pregnancy might injure the offspring, but there has been more doubt as to the effect of similar factors on the father, although it has been widely believed that alcohol and lead poisoning might influence the reproductive capacity of the male. After treating male rabbits with lead and alcohol, Leon J. Cole has compared their offspring with those of normal males. "What appear to be decisive results have already been obtained. In the case of alcoholic poisoning of the male the most marked result has been a lessening of his efficiency as a sire, the alcohol apparently having had some effect on the vitality of his spermatozoa. The 'leaded' males, on the other hand, have produced as many or more offspring than the normal fathers, but their young have averaged smaller in size and are of lowered vitality, so that larger numbers of them die off at an early age than is the case with those from untreated fathers." Such results, like the earlier ones of Stockard with guinea pigs, must not be interpreted as meaning that exactly the same thing occurs in man, but strong presumption is at least raised as to the actual existence of "racial poisons," which the eugenist must investigate directly in his human material.

The inheritance of various characters is being pursued exhaustively in pigeons, particularly with a view to working out the heredity of the small color differences which are so important to fanciers; the physiology of reproduction is also being studied. Tri-coat color in guinea-pigs, one of the favorite subjects for genetic analysis, has been taken up, while the effects of inbreeding are being noted in fowls, and the inheritance of color in Rhode Island Reds is made the particular subject of investigation. Inheritance of certain peculiarities in the reactions of rats to definite rations is being investigated, and finally, the inheritance of unit characters in cattle has been attacked in a project that will require many years for completion. Two very distinct breeds, the Jersey and the Angus, are being cross-bred, and in addition to merely superficial points, the behavior of such hereditary characters as total milk production, percentage of fat, size and shape of oil globules, viscosity and other properties of fat, rate of growth and form of animal's body are being watched.

The Delaware station has for six years been studying the effect of close breeding in pigs, and has now begun the same work with Guernsey cattle. As results in investigation of this subject are slow in appearing, the station can not yet publish any conclusions.

GRADING UP THE SCRUBS.

The grading up of a flock of scrub fowls is being carried on in a systematic way at the North Dakota station, by the

PURE-BRED RAMBOUILLET EWE

The Rambouillet is a French improvement of the Spanish Merino, in which fineness of wool has been particularly developed but in which mutton quality has also received careful consideration. The breed is comparatively resistant to parasites, is long-lived, can travel a long distance for feed and water, and instinctively herds closely. It is hoped that these valuable characteristics can be retained in the cross with the Siberian fat-rump, and greater hardiness gained. The ewe here shown is owned by the South Dakota Agricultural Experiment Station, and is the dam of the lamb shown in the following cut. (Fig. 12.)

use of Plymouth Rock males. Such a method of improving live stock has long been in use among cattle breeders, but the precise results to be expected when it is followed by poultry breeders are not so well known. The experiment is planned to yield information on this point. A carefully recorded experiment in grading up western range Merino sheep is also on foot.

How the white belt characteristic of Hampshire swine is inherited is being studied by the Iowa station, by cross and pure breedings. The slow work of studying heredity in cattle was taken up eight years ago, when a number of black polled Galloway females were bred to a white, horned, Shorthorn male. A considerable number of F_2 animals have been obtained and the study of inheritance of coat color and of the polled condition is well under way. An investigation of the significance of scurs in cattle is about to start.

The Ohio station is slowly accumulating data which will eventually provide material for analysis. The principal study in hand is that of the respective influence of sire and dam upon wool production, both in the grease and scoured, of the progeny; also upon the rate of gain and size of progeny. Individual laying records of Leghorn hens and their progeny are being kept and some cross-breeding in poultry done. The Department of Dairy Husbandry is just starting a study of the effects of long-continued inbreeding of dairy cattle

FAT-RUMP RAMBOUILLET LAMB

The first product of the attempt at the South Dakota Agricultural Experiment Station to breed a valuable type of sheep that will flourish in deep snow. This lamb was two and one-half months old when photographed. The tail is somewhat reduced in size from that of the maternal (Rambouillet) stock, and it is hoped to get rid of it altogether, and substitute a development of fat as in the paternal stock. (Fig. 13.)

on the form, size, vigor, production, etc., using Jerseys and Holstein-Friesians.

Creation of new breeds of sheep for the semi-arid conditions of the northwest has been undertaken by the South Dakota station, with the fat-rump sheep which N. E. Hansen brought back from Turkestan last summer. They will be crossed principally with the Down breeds. "We have the first crossbred lamb of this breed," Director James W. Wilson reports, "and I do not believe there is another sheep in the United States exactly like it. I intend to eliminate the tails in the crossbreeds and increase the development of the rumps so that the new breeds will be able to withstand the deep snows that we get frequently in the winter time on the range, when sheep can not get anything to eat. At this time they will live on the fat stored up in their rumps. These sheep came from the home of the camel and are noted for their endurance of hardships." Observations are also being made on the relation of feed and care of parents to the condition of offspring.

A NEW BREED OF FOWLS

Rather striking success has been produced in the Rhode Island station's study of inheritance in poultry. "The aim of this study has been to produce 'barring' as a result of crossing pure-bred black with pure-bred white fowls; and then to ascertain whether the manifestation of barring can be accounted for by any known methods of inheritance." A barred race has actually been pro-

A PHENOMENAL EGG PRODUCER

Queen Utana, a Single Comb White Leghorn hen bred ana owned by the Utah Agricultural Experiment Station. In five years she laid 816 eggs, a record which her owner thinks has never been equaled. She is one of a flock in which the Utah station is studying the inheritance of egg production. (Fig. 14.)

duced; it is evident, then, that an unsuspected factor for barring is carried latent in the germinal constitution of White Leghorns, the white parent used in the experiment.

Inheritance of egg weight is also being tested, the data appearing to show that any individual fowl lays eggs which vary only slightly from a certain average weight. Comparison with the record of the mother indicates that the weight of an egg is a character which is actually transmitted from one generation to another; the observers are now trying to find out how.

A parallel to the classic selection experiment of W. E. Castle on hooded rats is under way at the Rhode Island station with rabbits, in which material an attempt is being made to influence, by selection, what is known as the "English pattern." Selection is made of both plus and minus variations in each generation, in order to discover whether selection produces a cumulative effect, and can modify a character, which is recognized as a Mendelian unit. Should the experiment produce that result, it will add confirmation to the claim of Castle and others, that so-called unit characters are not the immutable things that they have some-

times been supposed to be, but that they are capable, within certain limits, of actual change by selection.[3]

The inheritance of egg production is a subject for study in New Jersey, where an attempt is being made on an adequate scale to breed a strain of fowls that will vindicate the genetist's claim that he can control this character. In this connection the question of close inbreeding is being studied. At present, the experiment is being run on two lines, one dealing with birds of high capacity and the other with low producers. It is by interbreeding these two lines that light is sought on the problems of heredity. General studies of inheritance have also been undertaken by the crossing of White Leghorns and Black Langshans, interesting facts about the source of barred pattern and the inheritance of black pigment having already come to light.

QUEEN UTANA AND HER PRODUCE

In the first year of her test, she laid 195 eggs, in the second year 193, third year 138, fourth year 161, fifth year 128; total production in five years 816 eggs. The Utah station believes tests of egg production which extend only over a year or two are likely to furnish misleading results, and is accordingly testing each hen as long as practicable. So far these tests have failed to confirm the belief that the inheritance of the egg-laying character is Mendelian in nature. (Fig. 15.)

Coat color in horses has been extensively studied at the Kentucky station, a report of results appearing recently in the Journal of Heredity, under the name of W. S. Anderson. The breeding of dairy cows from a scientific point of view is also under way.

PREPOTENCY.

The Kansas station, in its department of animal husbandry, is just starting an experiment to determine the relation of ancestry to prepotency. It is hoped that six years of experimental breeding will throw some light on the very important practical question of prepotency, about which at present the average breeder has usually vague and often incorrect ideas. The object of the study will be to measure the relation of cumulative effect of ancestry to character transmission in color, weight and size of bone; and to observe the type of inheritance of (a) preorbital brachycephalic face, (b) number of nipples, (c) fertility, (d) meat type as related to sex.

The department of zoology of the Kansas station is working with more technical subjects, one of which is the breeding of grasshoppers to determine the laws of inheritance in them. This work, Robert K. Nabours writes, "shows clearly the Mendelian type of inheritance, and the essential result of these experiments has been the extension of this principle to a considerable number of types" of a group of insects that is very low in the evolutionary scale. An attempt is now being made to find whether there is some correlation between the hereditary behavior of these

[3] On the other hand, several experimenters have shown that these results can be fully accounted for on the hypothesis of multiple factors. If this explanation is accepted, it means that the supposed unit character, which was modified by selection, is not an ultimate and indivisible unit at all, but an aggregate of a number of smaller units, which usually hang together, but may split up in certain crosses.

grasshoppers, and the chromosome complex of their germ-cells.

The crosses of Zebu with native cattle have been studied from a genetic point of view by this department, and a cooperative experiment in the inheritance behavior of crosses of Karakul and Lincoln sheep has been started.

From the Utah station, Director E. D. Ball writes:

"By breeding fowls, we are attempting to determine the possibility of improvement of the laying qualities of hens by continuous selection. In order to accomplish this it was considered necessary first to establish what the original laying capacity of an unselected flock of hens really was, as study of all of the records available did not seem to throw very much light on this question. Most of the records have been based entirely on the first year production, and the first year production as is shown in our Bulletin 135, appears to be a very poor indication of the laying capacity of a given individual or of a given strain of fowls. Therefore, the first object sought was to keep a sufficient number of flocks of unselected fowls under as near as possible normal conditions, to determine through a series of years what production could be normally expected from a flock and what the range of variation due to seasonal influences, individual differences, etc., really was. Bulletin 135 contains a summary of this work to date. It will be continued for some time in order to get still more accurate data and especially to determine the actual longevity and laying period of the White Leghorn hen.

PERIODICAL EGG RECORDS.

"This year's records, which are not included in this bulletin, are strikingly confirmatory of the general results. The records this year under identical care and attention of last year have fallen almost to the poor record of 1911, while every indication up to date is that next year's record will again be a good one, more forcibly illustrating the periodicity in production. We have in manuscript at the present time a detailed study of the winter egg production of these same flocks of hens in an attempt to determine whether there is any possibility of discovering a Mendelian factor, as is claimed by the Maine Station. We have been unable to find any Mendelism in the inheritance of this characteristic. Taking the records of hens from three to seven years and comparing them, we find that the individual fluctuates up and down in the same way that the flocks do, and that our winter egg production is even more variable than our total, that entire flocks have produced as low as 15 to 17 eggs in the first winter and from 35 to 40 the second year. According to Dr. Pearl's conclusion, it would seem that they must have acquired the high laying unit the second year. A third portion of this bulletin will take up the possibilities of improvement by selection,—it is, of course, only a preliminary study as it will be necessary to carry on the work many years to obviate seasonal variations and to select strains. We have, however, been able materially to modify productions by strain selection based on three years or more of production, and tested by an equal amount of production in the offspring."

A series of experiments of far-reaching importance, which should attract the attention of eugenists as well as livestock breeders, is under way at Missouri. "The influence of the age of the parents upon the offspring is at the present time largely a matter of opinion. A careful study is being made of the ultimate effect of mating young animals continuously. It is proposed to determine first the effect upon the immediate offspring; second the effect upon the mother; third the effect, if any, upon the race. Some interesting results have already been secured, particularly upon the effect of early mating upon the mother and immediate offspring." "The most important positive result is apparently the stunting effect on the young mother. Careful measurements indicate that early pregnancy interferes with the rate of growth and the ultimate development of the maternal parent." Several hundred animals are included in this experiment to date.

Sex-linked characters are being traced in poultry, where they have been found

particularly abundant in plumage pattern. The spangled pattern of the Silver Spangled Hamburg, for instance, is found to be sex-linked but, curiously enough, it is not transmitted as a unit for the entire body, the tail seeming to follow a scheme of distribution of its own; for in all reciprocal crosses, the tails of the F_1 birds are solid black. A correlation between the hen feathering characteristic of male Sebright bantams, and diminished fertility, is being sought by a series of bantam crosses.

Heredity scores another victory in its popular contest with environment, as the result of nutrition tests on cows. "The development of dairy heifers on different planes of nutrition, which has been under investigation for the past seven years, has resulted in some interesting facts. The results indicate that the method of feeding can influence the size, age of maturity and conformation of the dairy cow to some extent. The milk secreting function, however, does not seem to be influenced to any marked degree, if at all, by any ordinary variation in treatment. The milking function is inherited and cannot be influenced to any great extent by the ration the animal receives when young."

Eugenics Congress Postponed

The executive committee of the Second International Eugenics Congress has sent out the following notice:

"On account of the situation in Europe and America created by the Great War, the Executive Committee for the Second Eugenics Congress has regretfully decided that it will be impossible to hold the proposed Congress in September, 1915. The existing organization will be maintained, pending the reestablishment of settled conditions, when the Committee will determine upon a new date.

"The Executive Committee asks for the continued interest of those who have consented to serve as members of the several committees and as officers of the proposed Congress."

The Determination of Sex

Leonard Doncaster of Cambridge University contributes to *Nature* (October 1, 1914) a note on his breeding experiments with the gall-fly. It is well known that many Cynipid gall-flies have two generations in the year, one generation of parthenogenetic females and a second generation of males and sexual females. He has previously shown that any individual parthenogenetic female has either only male or only female offspring, and that the eggs of the male-producers undergo maturation of a different type from those of the female-producers. He suggested the possibility that the difference depended on the existence of two kinds of spermatozoa, but now finds this a mistake and decides that the "difference between the male-producing and female-producing females is derived from the sexual female parent." This type of sex-determination has not previously been known in the Hymenoptera, but the examination of over 9,000 flies bred make the experimenter certain "that nearly, if not quite, all the grandchildren of any sexual female are of one sex, and that of the sexual females, those which have male or female grandchildren are about equally numerous."

FEEBLEMINDEDNESS

A Ser'ous Problem to Eugenists—Two-thirds Due to Heredity—Many Grades of Arrested Development, Shading Imperceptibly Into Normal Population—Manner of Inheritance.

A Review by the Editor.

TO THE eugenist, no problem is more immediate and serious than that of feeblemindedness. Ever since eugenics became a recognized science, its followers have devoted to feeblemindedness what many have thought was an altogether disproportionate amount of time. With added knowledge, the problem has increased rather then decreased in complexity and urgency. It is still far from being settled, but the past year has seen studies which do much to dispel the fog; and among these the most noteworthy by far is the work[1] of Dr. H. H. Goddard, director of the research laboratory of the Training School at Vineland, New Jersey, for feebleminded boys and girls. As a result of five years of research, Dr. Goddard is able to present detailed pedigrees of 327 children in the institution, nearly all of them representing at least three generations. They are sufficiently complete, it appears, to furnish material from which anyone who cares to investigate can draw his own conclusions.

Feeblemindedness has been defined as "a state of mental defect existing from birth or from an early age and due to incomplete or abnormal development in consequence of which the person affected is incapable of performing his duties as a member of society in the position of life to which he is born." It is, in other words, merely a state of arrested mental development (with some physical abnormalities in the lower grades), and is thus easily distinguished from insanity, which is a disordered rather than an arrested development of the mind. The feebleminded are for convenience classed as idiots, imbeciles or morons, according to the point at which their development was arrested, the idiot being one whose mental age is two years or less, as measured by such a test as the Binet scale.[2] An imbecile may have a development of from three to seven years, mentally, while the term "moron" in the United States designates one whose mental age is from eight to twelve years. As a fact, the moron class shades off imperceptibly into the normal bulk of society.

DEFECTIVES NUMEROUS.

The amount of feeblemindedness in the community is much larger than anyone suspects who has not investigated conditions. In the United States Goddard thinks there are between 300,000 and 400,000 feebleminded persons, but the distribution is very irregular; in some communities few are to be found, while in the state of New York alone the number has been placed as high as 30,000. These figures refer only to the feebleminded who can actually be distinguished as such—the "patent" individuals. The number of "latent" individuals, those not actually feebleminded themselves but carriers of the defect in their germ-plasm and capable of passing it on to their descendants, is necessarily vastly larger.

The taint, then, is so widespread that the student of heredity is amply justified in looking on it as the most important cacogenic factor in the community.

[1] Feeblemindedness, its Causes and Consequences, by Henry Herbert Goddard, Ph. D. Pp. xii + 599, price $4.00 net. New York, The Macmillan Company, 1914.

[2] Every eugenist should be familiar with the principles of the Binet test, which has often been described. "The Binet-Simon Measuring Scale for Intelligence," by H. H. Goddard, is sold by the Training School, Vineland, N. J., for 15 cents. See also "Tests for Mental Defect," by Dr. Howard A. Knox, in the Journal of Heredity, V, 3, 122, March, 1914.

Fortunately, however, not all feeblemindedness is due to heredity. Just how much is due to other causes, no one can say: Goddard thinks that one-third of the cases examined in his work at Vineland may be ascribed to some other cause than inheritance. These appear to be due in some cases to a neuropathic ancestry, in others to accident before, at, or after birth, in others to some disease such as scarlet fever or spinal meningitis, during childhood. Cases of such origin are not transmitted to offspring, and therefore are of little importance to the genetist. By no means all cases where accidents are blamed for feeblemindedness are really due to that cause, it appears, further investigation showing enough feeblemindedness in the ancestry fully to account for the child's condition; on the other hand, the fact that a certain child is left feebleminded by an attack of disease, while a dozen others who have it at the same time escape unscathed, indicates that here too a weakness of some sort in the family stock may explain the resulting arrest of mental development in the particular case.

There are a number of supposed causes of feeblemindedness which Goddard finds to have little reality, as far as his own experience goes. Thus there seems reason to doubt that parents' alcoholism arrests the child's mental development to the extent of leaving it among the feebleminded. Paralysis, epilepsy, insanity or syphilis in the parents seem of themselves insufficient to account for a child's feeblemindedness; neither can tuberculosis or consanguineous marriage explain such a result. Where these things occur, they occur not as causes, but as corrollaries or effects, of a defective germ-plasm.

THE "CRIMINAL TYPE"

On the other hand, feeblemindedness itself is at the bottom of an amount of social abnormality which the ordinary sociologist—much less the layman—rarely realizes. The so-called "criminal type," Goddard believes, is merely a type of feeblemindedness, a type misunderstood and mistreated, driven into criminality for which he is well fitted by nature. The chronic alcoholic is often to be explained by an arrest of mental development, rather than by original sin or moral perversity. The prostitute, in from one-fourth to two-thirds of the cases investigated in different cities, is found to be feebleminded, and should be humanely segregated rather than punished or "reformed." The ne'er-do-wells of a community are usually found, if adequately tested, to be morons; the adult vagrant and the confirmed child truant usually belong to the same type. The expensive "special classes" of the public schools are filled with children a large part of whom are morons; an attempt is made to educate them, when an examination of their ancestry would show that it is humanly impossible to educate them, in the way that their playmates are educated. In fact, such tests as those of Binet, wherever applied, have rarely failed to show that the number of social problems whose solution lies with genetics rather than with ordinary sociology is far greater than anyone except the eugenist realizes.

Unfortunately, the exact rôle of heredity in any given case can only be found by an investigation of the pedigree—a labor that involves much expense and time as well as the indispensable aid of a skilled field worker. Nay, the very presence of feeblemindedness is often ignored, and an individual blamed for perversity, incompetence or stupidity, when the examination of a trained psychologist would show a discrepancy between mental age and physical age. The lower grades, the idiots and imbeciles, can indeed be distinguished by almost anyone, but the moron, particularly of the higher grade, is detected only by the careful observation of a competent investigator equipped with psychological tests and experience in using them. And even there, one finds a border line where one can not with confidence say whether the subject is normal or abnormal—these words being merely relative terms without exact definition.

"The feebleminded in bulk—if we exclude special types of idiots—are not

a special race, sharply differentiated from normal-minded folk," says Karl Pearson. "There is every grade of feeblemindedness . . . and as far as mentality is concerned no sharp line can be drawn across the population, and those on one side of it treated as normal and those on the other as mentally defective,"—a statement of the case that I think Goddard and most other students would accept.

This fact of continuity has an important bearing on all work with the feebleminded as a class. To the student of heredity it is particularly important, because most of the present-day studies of heredity start with the assumption that each character inherited is a unit. Can we speak of a unit character, when it shades off imperceptibly into another —can we call feeblemindedness a unit, when no line can be drawn between it and its supposed alternative or "allelomorph," a normal mind?

THE UNIT CHARACTER QUESTION

This question has caused bitter disagreement among eugenists. The earlier students of the subject assumed that it was a unit character and interpreted their pedigrees in that light. They called it a recessive trait, normal mentality being dominant. From the very beginning, psychologists had on the whole refused to assent to this proposition. Goddard himself "confesses to being one of those psychologists who find it hard to accept the idea that the intelligence even *acts like a unit character*," although his own figures force him to say that "there seems to be no way to escape such a conclusion." But the question was not really made a crucial one among geneticists until the publication of three bulletins from the Galton Laboratory of London, devoted largely to an attack on exactly this feature of recent American work in eugenics.

In the first one,[3] Dr. Heron, the assistant director, devoted himself wholly to a destructive criticism of studies which considered mental defect from a Mendelian viewpoint—which assumed, in short, that feeblemindedness was a unit character and so behaved in inheritance. He was answered[4] by some of the men he attacked; but as the controversy was fairly well aired in the daily as well as the scientific press, it will not be renewed here.

Following this came another contribution from London,[5] in which measurements of the intelligence of school children in Stockholm were presented to prove that feeblemindedness was not a unit character but showed continuity with the normal population. Still later Karl Pearson published in the same series a lecture[6] reviewing the whole situation, and pointing out the need for some accurate measurement of the higher grades of mental deficiency. "That a real measure will be found—short of the experimental method of testing actual success or failure in the rough and tumble of life—I am convinced," he concludes, "but I doubt whether it has been found at present and its discovery will not be expedited by any scientific dogma that asserts all mental defect is of one kind, and is due to the absence of a determiner, a lack which the feebleminded share with our ape-like ancestors."[7]

[3] Mendelism and the Problem of Mental Defect. I. A Criticism of Recent American Work, by David Heron, D. Sc. Pp. 62, price 2 s. net. London, Dulau and Company, 1913.

[4] Eugenics Record Office Bulletin No. 11. Reply to the Criticism of Recent American Work by Dr. Heron of the Galton Laboratory, by C. B. Davenport and A. J. Rosanoff. A Discussion of the Methods and Results of Dr. Heron's Critique, by C. B. Davenport; Mendelism and Neuropathic Heredity, by A. J. Rosanoff, M. D. Pp. 44, price 10 cents. Cold Spring Harbor, Long Island, N. Y., February, 1914.

[5] Mendelism and the Problem of Mental Defect. II. The Continuity of Mental Defect, by Karl Pearson, F. R. S., and Gustav A. Jaederholm, Ph. D. Price 1 s. net. London, Dulau and Company, 1914.

[6] Mendelism and the Problem of Mental Defect. III. On the Graduated Character of Mental Defect and on the Need for Standardizing Judgments as to the Grade of Social Inefficiency Which Shall Involve Segregation, by Karl Pearson, F. R. S. Pp. 51, price 2 s. net. London, Dulau and Company, 1914.

[7] This refers to the suggestion of C. B. Davenport (see *Popular Science Monthly*, January,

The smoke of controversial battle must not obscure from the public the fact that as to the hereditary nature of much if not most feeblemindedness there is no doubt. This alone would suffice to justify a eugenic campaign. The further question of how it is inherited is purely a technical one. Nevertheless, it is one which has great importance, to society as well as to the professional geneticist. What, then, is the layman to think about the way in which this condition is transmitted?

It seems impossible to overlook the ease with which the puzzle can be explained by the hypothesis that feeblemindedness is due to not one but many unit characters, which in general, *but not always*, cling together in a group, when transmitted. When they stick together in one group, they produce the appearance of a single unit character, and thus yield the approximate Mendelian proportions which Goddard found when he tabulated his matings, and which his predecessors also found in their researches. But when some other factor comes into play, this group may be broken up and only a part of the units passed on to a given individual. They may be enough in number to produce obvious feeblemindedness; they may be so few that the individual who receives them appears, in any ordinary environment, to be little inferior to his comrades.[8]

NEED FOR MORE RESEARCH.

If this hypothesis be the true explanation of the behavior of feeblemindedness in heredity, the antagonism between the biometrists with their insistence on continuity and the Mendelians, with their insistence on the unit character, is only apparent. Neither side at present accepts such a solution, but it seems probable that the further prosecution of genetic studies will result in a more general acceptance of the idea that supposed unit characters are multiple and that visible traits are complex in nature.

But as I have already said, we must not get so much interested in a question of secondary importance as to forget the point of first importance—namely, that feeblemindedness is a widespread defect, largely due to heredity, which threatens to lower the intellectual level of the whole race unless careful selection in mating keeps it from infecting more sound stock each year. As feeblemindedness involves a lack of self-control and an inability to understand ethical questions, the possessor of it can not be expected voluntarily to take any steps which will prevent the transmission of his defect. With society is the responsibility for protecting itself.

But, the opponents of eugenics object, Nature will take care of the whole matter. These diseased conditions of the germ-plasm "run out;" the stream always tends to purify itself. "A study of the charts here presented," Dr. Goddard remarks, "will hardly be found reassuring in this direction." In the absence of any interference, the number of feebleminded usually becomes larger with each generation; if they are of the very lowest grade, it is true that they leave no descendants, but among the morons the taint is more likely to spread than not. And even in cases where it seems to have died out, where no feeblemindedness appears for three or four generations, we can not be sure that the condition has not become merely latent. The geneticist, indeed, who has seen exactly analogous cases in his breeding experiments, will feel quite sure that it is merely latent, ready to appear again when the proper mating is made. There is no safeguard for society in a dependence on some

1912) that feeblemindedness is a survival of the mentality that characterized the ape-man: that the condition has been carried down unchanged in the stream of germ-plasm ever since.

[8] For a clear statement of this hypothesis see "Nature of Mendelian Units" by G. N. Collins, Journal of Heredity, V, 10, 425, October, 1914. This hypothesis will also harmonize the conflicting views on albinism in man, where the same statistics are interpreted by biometricians to show continuity and by Mendelians to show segregation of a unit character. See the statement of the two sides of the case in the Journal of Heredity, V, 11, November, 1914: "Albinism in Man" (a review of the work of the Galton Laboratory) by A. E. Hamilton and "The Laws of Naudin-Mendel" by Dr. E. Apert.

mystical help from Nature; it must protect itself by deliberate intervention.

At present society fulfils this obligation in a very inadequate manner, by segregating, in some states, a small part of the most hopeless grades of defectives. Even then, they are not always prevented from propagating their kind. There is general agreement that effective segregation should be extended, but it is of course difficult to say who should and who should not be included. Pearson thinks that it is merely "a matter of practical utility where we draw the line which shall legally define mental defect for purposes of segregation. It certainly should not be done under four years' mental defect judged by adequate Binet tests. This will only cut off about 20 to 30% of those at present classed as feebleminded in the special schools. The remaining 70 or 80% may be, and probably are, incapable of fending for themselves in ordinary life; they are also socially inefficient, but ultimately, on other grounds, temperamental or moral, not merely intellectual: they take a view of life which is in distorted perspective, and they are out of harmony with their economic or social surroundings. They may be more dangerous than those in whom true *mental* defect is far greater, and they may more urgently stand in need of segregation," because while the groveling idiot is unlikely to become a parent, the moron is almost certain to do so, either legitimately or illegitimately, unless prevented by society from doing so.

How shall this restraint be exercised? In the first place, says Dr. Goddard, as many of the high grade defectives as possible must be effectively "segregated" in their own homes, by the intelligent action of their own relatives. As to the rest, the lower grades must obviously be gathered together in colonies, not only for the protection of society, but for their own protection. But if the higher grades are to be included, it will mean the establishment of at least a thousand colonies, each containing 300 or 400 individuals—a burden which the nation is not likely to assume at present.

"The facts," to Dr. Goddard, "show that we must colonize as many of the feebleminded as we possibly can, that we must sterilize some, and then we discover that we have only tithed the problem, we have not solved it." The rest—all of them, of course, representing the higher grades—should, he says, be educated.

Impossible?

"That depends on our definition of education," he answers. They can be trained, if recognized and taken in hand at an early enough age, to do many kinds of work which do not demand the possession of judgment or real intelligence, but which depend rather on habit. Few of them can be taught usefully to read, write, or count, but there are many kinds of manual labor that they can be trained to do with sufficient proficiency to pay for their cost of maintenance. Even should the community find itself unable to stop altogether the production of this class, at present, "may it not be possible that we will find use for all these people of moderate intelligence, and that the production of so many high grade feebleminded is only the production of so many more people who are able and willing to do much of the drudgery of the world, which other people will not do?"

There remains a question of first importance to the eugenist—the relation to marriage selection of the moron who is left at liberty. Here students sometimes seem to fall into no more than two classes: those who propose wholesale sterilization, and those who propose nothing. Dr. Goddard takes a middle course, thinking sterilization adequate to dispose of "a narrow zone" of cases; for the rest, it appears that general education of the public to realize that morons exist in large numbers, in all classes of society, and that they can not by outward appearance be detected, will do much, perhaps all that is possible, to abolish the problem. When the man or woman contemplating marriage realizes the desirability of investigating the ancestry of a prospective mate, the infection of sound stocks by marriage between normal persons and high-grade morons or those who, wholly normal in themselves, are carriers of latent feeblemindedness, will largely cease.

SUPERIORITY OF THE ELDEST

Investigation Among Professors in Italian Universities Shows that the First-born Are Most Frequent Among Them, While Children Born Late in the Generation Are the Rarest.[1]

CORRADO GINI
Professor of Statistics in the University of Padua, Italy.

ON SEVERAL occasions I have called the attention of readers of this Review to the importance of the study of the characteristics of children with relation to their order of birth in a fraternity. The importance is double:

(1) to determine whether the privileges accorded in so much past legislation and some even at the present day, to the first-born, are justified;

(2) to judge what consequences the habit, widely gaining ground, of limiting the size of a family, will have on the quality of future generations.

Before or after me, numerous authors have considered the question: Pearson, Heron, Macaulay, Weinberg, Crzellitzer, March, Ploetz, Hansen, Goring, Greenwood, Jr., Yule, Cobb, Rivers.[2] Some think defects and abnormalities are more frequent in the first-born; others, of whom I am one, dispute the correctness of the methods followed in many cases, and the consequent validity of the conclusions.

Often, indeed, a pessimistic conclusion about the quality of the first-born has been announced, as a result of the observation that defects and abnormalities were particularly frequent among the first-born, or that eldest children were found most frequently among defectives and abnormals, without taking into consideration the fact that such a result might be due not to the fact that in a given family the eldest were inferior to their successors but to the circumstance that the sick and abnormal are most common in small families, which furnish no children except those that are of relatively low birth-rank. In some way, then, it is necessary to elimate from the calculations the influence of family-fecundity, if we are to get a clear view of the influence of birth-rank.

But there is another point to consider. If in an investigation correctly carried out, it were shown that the first-born present bad characters more frequently than their brothers, still it would not be demonstrated that they are, on the average, inferior. It might be explained by the assumption that the eldest are merely more variable, and that they more frequently show in an extreme form either bad characters—or good ones.[3] Investigations on the distribution of maladies and abnormalities according to birth-rank ought to be followed by direct investigations on the distribution according to birth-rank, in single families, of the persons who excel in physical or mental characters. On this point the only observations hitherto made, so far as I know,[4] are the inadequate ones of Axenfeld and Robinovitch, based on insufficient numbers, and contradictory in their results.

The best way to fill up this lacuna

[1] Translated from Rivista Italiana di Sociologia, Anno XVIII, fasc. II, Marzo-Aprile, 1914.

[2] For the most recent contribution to the subject see Chase, John H., Weakness of Eldest Sons. JOURNAL OF HEREDITY, V, 5, 209, May, 1914.—The Editor.

[3] This is the explanation offered by Havelock Ellis in Hereditary Genius, for the fact that many of England's most talented men have been eldest sons.—The Editor.

[4] Alexander Graham Bell has investigated the inheritance of longevity in nearly 3,000 cases. His figures (not yet published) show the first two children to be almost exactly average, as far as longevity is concerned. Beyond them the curve rises, and the next two children are superior to the average, the fifth child is again average, while the later children—from the sixth on—show an inferior longevity.—The Editor.

in our knowledge is to address to all the persons who excel in any particular walk of life, either by physical or mental powers, a simple questionnaire containing questions like this:

(1) How many children had your parents?

(2) Among these children what is your own order of birth?

A questionnaire of this sort, signed by Sig. F. Floris, laureate in jurisprudence at the royal university of Cagliari, and by myself, was sent out during the present year to all the professors in Italian universities. We received 445 replies, of which 416 related to families containing at least two children, and therefore of value to this investigation. They show (a) how the professors in Italian universities are distributed in regard to birth-rank; and (b) whether, in a given family, the frequency of attainment of a university professorship is independent of the birth-rank, or whether it varies with the latter, and if so, in which sense.

The second column of the following table answers the first question. The 141 first-born professors came from 416 families with at least two children, and 29 each of whom is an "only child" ought to be added; one thus obtains a total of 170 first-born professors among the 445 families which furnished university professors. Column 4 answers the second question: I take the actual number of professors for each birth-rank as 100, and thus obtain the theoretical number which we would have gotten if, in each family, the quota of professors furnished was quite independent of birth-rank.

Order in generation.	*a* Number of professors from families of at least two children.	*b* Theoretical number on the hypothesis that distribution of professors is independent of order of birth.	100a / b
1	141	87.4	161
2	82	87.4	90
3	58	69.9	83
4	45	54.2	83
5	32	38.7	83
6–7	31	44.9	79
8–9	20	19.8	79
10 upward	7	13.4	52
Total	416	415.7	100

The actual number of university professors is thus seen to be greater than theoretical expectation among the first born and less than expectation among the cadets: compared with theory, the difference is seen to be the less, the higher the birth-rank of the individual.

Taking into consideration the rigorous system, based on competition, by which entry to an Italian university is regulated, it must be admitted that the Italian university professors represent a stringently selected group of the population, and it can not be doubted that their intellectual level is, on the average, notably above that of the class from which they spring. It seems fair to conclude, therefore, that the first-born, at least so far as concerns scientific attainment, are superior to their juniors and that, among these latter, the last-born are inferior to their predecessors.

Two objections particularly can be urged against these conclusions.

(a) Women rarely aspire to a university career. To decide the influence of birth-rank on scientific attainment, we should therefore restrict our inquiry to the number of male children born to

the parents of the person addressed, and to his own birth-rank among these males.

I reply that the proportion of the sexes does not vary much with the birth-rank, and that its slight variation could not possibly change the regular diminution, according to birth-rank, of the figures in column 4. It must be remembered that we paid no attention, in our questionnaire, to the sex of the professors addressed (an omission made desirable by the need of simplifying the demands as much as possible), and that this omission can have no other influence than to make the influence of the birth-rank appear attenuated, in the results.

(b) The frequency of professors among the first-born is favored by family circumstances, and in particular by the desire of parents to see their eldest child occupy a position that will reflect honor on the family. Quite apart from biological influences, among the various categories of children, social influences might thus explain the greater abundance of professors among the first-born.

This objection must receive careful consideration; yet the fact remains that the relation of actual number of professors to theoretical calculation, even among the younger children, diminishes *regularly* as the order of birth-rank increases.

The conclusion that the first-born are superior to their juniors, at least so far as concerns scientific attainment, must nevertheless be acepted under reserve, until further data allow us to clear away all doubt. This result will probably be attained after similar questionnaires have been sent to other categories of persons, distinguished physically or mentally, among whom social considerations in the family would not act, or at least would not act in the same way, as among university professors. The investigation reported above must not be taken—nor do I describe it—as more than a first step destined to be followed, in case of success, by more elaborate questionnaires among other classes of persons eminent in all branches of human activity: in the literary, artistic, military, bureaucratic, commercial, financial, political, and athletic fields.

Adopting our idea, the Italian Committee for the Study of Eugenics has included in its program the carrying out of these investigations. The importance of this organization, and of the object of the study, ought to result in as numerous replies to further inquiries as have honored our first essay.

The Proper Age For Marriage

The intellectual qualities of the children produced must largely decide the question whether early or late marriages are the most desirable from a eugenic point of view, according to Dr. Värting, who has recently published [1] a study of 75 distinguished Germans, whose parentage he has investigated. He comes to the somewhat unusual conclusion that the marriage of a young man with a woman of mature years is likely to produce the most talented children: 24 years he selects as the minimum age at which girls should wed, and 30 as the age beyond which a man ought not to venture into matrimony. Aside from the inadequate number of cases with which he deals, Dr. Värting's conclusions hardly seem justified by his material, particularly since more than half of the fathers of distinguished sons listed by him were more than 30 years of age at the birth of the son in question. His ascription of Nitzsche's insanity to the youth of his mother (18 years) can be matched by the fact that Frau Aja was only 19 when she bore Wolfgang von Goethe. On the whole, the book can not be considered a very substantial contribution to the interesting and important subject, which has been handled by Redfield in America in a far more worthy way.

[1] Das günstigste elterliche Zeugungsalter für die geistigen Fähigkeiten der Nachkommen. Pp. 63, Würzburg, 1913, C. Kabitzsch, M. 1.20.

A NEW WALNUT

Mutant Somewhat Similar to Live Oak Appears in California in Four Different Localities—Not a Walnut-Oak Hybrid—Origin of All Walnut Species Possibly by Mutation.

Ernest B. Babcock

Professor of Genetics, College of Agriculture, University of California, Berkeley, Calif.

IN THE spring of 1901, in a southern California nursery owned by D. C. Disher, there appeared a dozen or more seedlings, the first recorded specimens of a new form of the native California Black Walnut, *Juglans calfornica* Wats. Two of these trees still remain where they were first transplanted from the seed bed while several were given away and are now growing at various places in California. The two that remain on the site of their origin have been described and named[1] as a new variety, *quercina*, because the general appearance of these trees, with their small, dark green leaves, is somewhat like that of the California Coast Live Oak, *Quercus agrifolia* Née. Fig. 16 shows these trees as they appeared in 1907. Their similarity to oaks is not in specific details but in general appearance, in spite of the fact that this same form has been named,[2] but without a proper botanical description, "*Juglans quercifolia*" by another writer. I maintain that *the leaves are not oak-like in form*, which is the important mark of resemblance. Neither are they closely similar in size, which is quite variable, nor in color and texture, which are distinct from live oak as well as from black walnut. Fig. 17 illustrates most of these points, while fig. 18 shows that the fruits of *quercina* are simply reduced black walnuts.

This lack of resemblance between the new form of walnut and the live oak is an important point when we consider the claim set forth that this form is a natural hybrid between walnut and oak. It happened that the wild black walnut tree which was the parent of the original specimens of the new form, stood beside a large Coast Live Oak tree and this fact led Mr. Disher to think that his peculiar walnut seedlings were natural hybrids between oak and walnut. Under the circumstances it is not strange that a layman should be led into error, but it is difficult to understand how any one of scientific training can persist in so evident a fallacy. To be convinced that somebody not only maintains this fallacy but is actively engaged in misrepresenting the true nature of these trees, it is only necessary to read the following communication.[3]

———, Cal.
August, 1914.

"President State Normal School,
———, Cal.

"Dear Sir:

"I am now able to offer you what I believe to be the rarest and the most remarkable tree in the world. It is a hybrid between a live oak and the California walnut. It bears oak-like leaves and walnuts. It has been named *Juglans quercifolia*. It is the dominant of Mendel from which I should be able to rear a recessive tree bearing walnut-like leaves and acorns.

"I have sold many of these trees to Kew, Edinburgh, Berlin, New York and elsewhere. I can supply these dominant trees at $10.00 each and probably recessives next year. A discount on dozen lots.

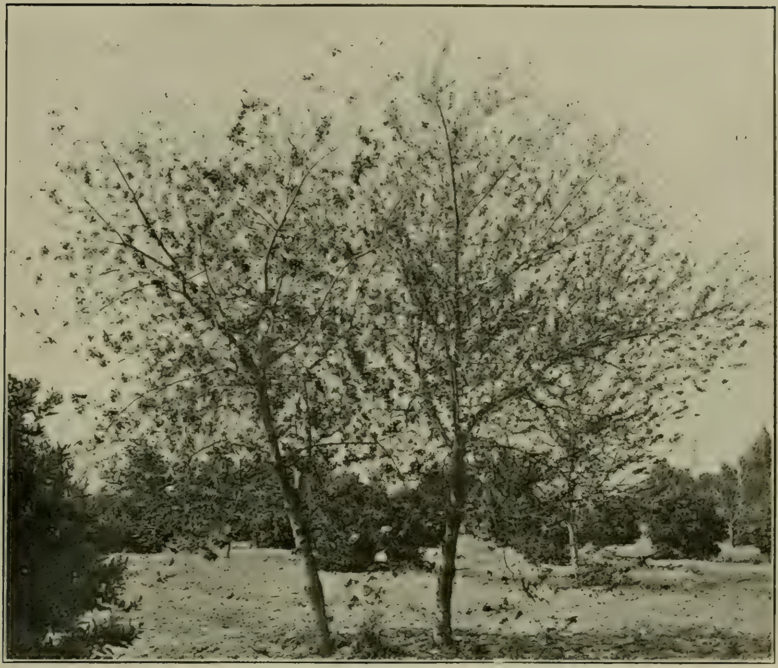
"Growing a dominant and recessive side by side you would have the most remarkable demonstration of Mendel's law to be found on earth. An oak bearing walnuts and a walnut bearing acorns!

"I am expecting to locate this tree at the

[1]Babcock, E. B. Studies in Juglans I. Study of a New Form of *Juglans californica* Wats. Univ. of Cal. Pub. Agric. Sciences, vol. 2, No. 1, 1913.

[2]Pierce, N. B. A New Walnut. Science n. s. vol. 37, No. 955, p. 613, 1913.

[3]This letter was sent to the writer by a member of the faculty of a state normal school with a request for an expression of opinion as to its veracity.



ORIGINAL SPECIMENS OF THE NEW WALNUT

Two of the original trees of the California mutant walnut which has been named *Juglans californica* var. *quercina*. The left-hand tree bears both staminate and pistillate flowers and produces a crop of nuts each year, which when planted produce trees resembling the parent. The right hand tree has only staminate flowers or, occasionally, abortive pistillate flowers, and hence produces no nuts. (Fig. 16.)

Normal School at ——— and therefore make you this offer. I may place some at——— also.

Sincerely yours,

———————

(P. S.) "There is no more beautiful tree for school grounds to be found on earth!"

I do not assert that this misrepresentation is made wilfully or even consciously. The purpose of this article is merely to expose the fallacy and inform those who are interested in this new form regarding its true nature. That it is not a hybrid but rather a mutation is proved by two supplementary lines of evidence, the result of my investigations during the past seven years.

In 1908, 1910 and 1911 I made a large number of cross-pollination experiments under bag on native black walnut trees with pollen from the live oak and two other native oaks with the result that from live oak pollinations alone I have 70 seedlings, 48 of which are six years old and, of these, 30 bore their first crop of nuts in 1913. The reciprocal cross was attempted but no seeds matured. Briefly, but accurately, I can state that no trace of oak nor of *quercina* characters can be found in any of the first generation seedlings from oak pollinations. Moreover, over 2,000 nuts were secured from 30 of the F_1 trees in 1913 and the seedlings were raised this year. Again there was absolute failure to detect any oak or *quercina* characters. Both the F_1 and F_2 seedlings appear like the California Black Walnut. Although this is negative evidence, it indicates strongly that the original *quercina* trees did not originate through natural hybridization between walnut and oak.

In 1911, through the generous cooperation of William Tyler, of Garden Grove, California, I ascertained that the new form of walnut was produced by at least one individual in a row of 20 or 30

WHY THE NEW FORM IS NOT A HYBRID

Although the general appearance of the mutant is somewhat like that of the California live oak, its leaves show little resemblance, when studied in detail. In the center is a typical leaf of the Southern California black walnut (*Juglans californica*), the parent of the mutant; at the left is a series of leaves of the mutant, which has been given the variety name of *quercina;* at the right are typical leaves of the Coast Live Oak, (*Quercus agrifolia*, which has been claimed as one of the parents of *quercina*. It will be noted at once, however, that the leaves of the mutant are compound, except in one case where there is a tendency toward a simple form. The two end leaves are the most characteristic of *quercina*, the other types being comparatively rare. (Fig. 17.)

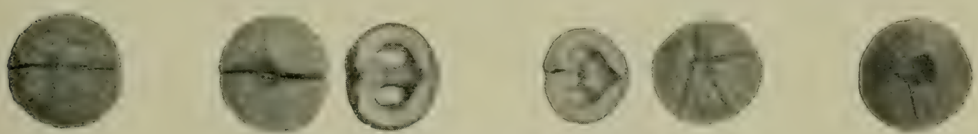
California Black Walnut trees from which Mr. Tyler obtained nuts for his nursery. In 1912 I had the crop from each of 21 of those trees gathered separately and thus selected the particular tree which produces *quercina* seedlings. This tree is known as No. 16. In 1913 I had about 350 clusters of nuts on this tree gathered separately and tested and found that 42 clusters produced the new form, but, strange to say, there was only one *quercina* seedling among those from each cluster, the others being typical black walnuts. A fuller report on this work together with critical discussion appears elsewhere.[4]

NO MENDELISM FOUND.

No oaks, either native or exotic, are known to occur in the region of Garden Grove—certainly none in the immediate vicinity of tree No. 16. This eliminates the possibility of origin of the *quercina* progeny of tree No. 16 through hybridization with oak. The limitation of the production of *quercina* seedlings to only one of the 21 black walnut trees tested, indicates that the mutation does not occur in the staminate flowers of No. 16 or its neighbors but rather in the pistillate flowers of No. 16 itself. And, further, the fact, which has been amply demonstrated, that the new form does not breed true but usually produces some typical *californica* seedlings among its progeny, shows conclusively that the mutations occur in the pistillate flowers *before* fertilization, so that each *quercina* seedling produced by a black walnut tree is a hybrid in the sense that it combines the characteristics of the mutant and the parent and so reproduces both types. The proportion of *californica* and *quercina* seedlings found in the progeny of fruiting specimens of the new form is quite different for different specimens. I have tested the seeds from three different *quercina* trees and can state positively that I have never found any oaks among the progeny nor any Mendelian ratios between the numbers of *californica* and *quercina* seedlings produced. These facts considered together with the complete absence of specific oak characters in the new form should effectually dispel the notion that hybridization with oak has had anything to do with the origin of the new form.

The original source of the new variety was the tree discovered by Disher in Santa Ana canyon, the parent of the original *quercina* trees shown in fig. 19. This tree was destroyed before the writer had seen its progeny. The next source to be discovered was a single tree in Santa Monica canyon near Los Angeles. Among a lot of nuts gathered in 1909 from wild walnut trees growing in that region, there was one nut that produced a *quercina* seedling. The third tree found to produce the new form is No. 16 in Garden Grove, California. The row of trees, of which it is one, was planted perhaps thirty years ago and I have not learned the location of their parents but all the individuals in the row are southern California Black Walnuts.

The fourth source of the new variety has just been discovered. It is of unusual importance for reasons of



NUTS OF PARENT AND MUTANT

At the left, three nuts of the Southern California black walnut; on the right three nuts of the variety *quercina* which suddenly appeared as a mutant from it. There is no real distinction between the two nuts, and not the slightest trace, in those on the right, of any influence of an oak, which is alleged by some horticulturists to have been one of the parents of the new form. (Fig. 18.)

[4]Babcock, E. B. Studies in Juglans II. Further Notes and Observations on a New Form of *Juglans californica* Wats. Univ. of Cal. Pub. Agric. Sciences, vol. 2, No. 2, 1914.

THE NUTS IN CROSS SECTION

At the left, typical nuts of the Southern California black walnut, at the right, typical nuts of the new variety *quercina*. Although this has been called a walnut-oak hybrid, there is nothing in the nuts, leaves, flowers or any other part of the plant to indicate that an oak entered its parentage, and as it has been produced several times under controlled conditions, from walnuts which were known not to be cross-pollinated, the story of the walnut-oak hybrid must be set down as a myth. (Fig. 19.)

interest to biologists. The three *quercina*-producing trees above mentioned are all southern California Black Walnuts and would be classified botanically as *Juglans californica*. The newly discovered source of *quercina* is the northern California Black Walnut, which has been named *Juglans californica* var. *hindsii* Jepson.[5] It is a form so different from the southern type of tree that it might easily be mistaken for a distinct species. The circumstances involved in this new appearance of *quercina* are too complicated to be related in full here. Let it suffice to say that without doubt *quercina* has sprung from *hindsii* as well as from *californica*. Since *quercina* comes from *californica* by mutation it is practically certain that *hindsii* produces the new variety by the same process. Although it does not follow of necessity, yet these facts would seem to indicate that *hindsii* also originated from *californica* by mutation. A full statement with illustrations concerning this latest development in the history of the oak-like walnut will be made as soon as it is feasible to do so.

It is worthy of note that this is a mutation in which there has been a change in all gross characters—size, shape, color and texture of leaves, size, form and number of parts of flowers, color of bark, habit of growth, etc. Such a transformation has been called aggregate mutation and cases have been reported in cotton, tomato, tobacco and evening primrose. The walnuts and their relatives are recognized by botanists and paleontologists as among the oldest of the angiosperms. Many species of walnuts existed in the various periods of geological history back to the Cretaceous. The known occurrence of one such aggregate mutation as produces *quercina* suggests that some if not all the species of walnuts existing or extinct may have originated in a similar manner.

That this new walnut is not a natural hybrid between oak and walnut, is indicated by the negative results of my experiments in artificial hybridization and proved by the demonstration of its origin through mutation, which has occurred not once but many times in at least four different trees of the California Black Walnut.

[5] Bul. S. Cal. Acad. Sci. vol. 7, p. 23, 1908.

Prepotence in Plant Breeding

The work of breeding new flowers, fruits and vegetables from natural or artificial crosses, has been, and I believe can still be, carried out excellently with a minimum of Mendelian theory. The most important idea, I think, is that of *prepotence*, or transmitting power, or strength of heredity, as it is sometimes called. This rather loose term, so far as I have seen, has been used to embrace at least the following different Mendelian cases:

(1) The dominance of a character in a first-generation hybrid. (The dominant parent is prepotent for the character.)

(2) The presence in the prepotent parent of a number of separate dominant characters, or of a number of characters inherited as a dominant unit. (An important case of prepotence.)

(3) The excess of dominants from the cross of a positive homozygote with a recessive, over those from the cross of a heterozygote with the recessive. (The pure-bred is more prepotent than the mongrel.)

(4) The presence of the dominant character in *all* the progeny of the back cross of a hybrid with its dominant (prepotent) parent, whereas only a fraction show the recessive character when the hybrid is crossed with the recessive parent.

(5) In cases of imperfect dominance, the difference in *appearance*, as well as in transmitting power, between the homozygous dominant and the heterozygote. (Recognition of prepotence by external characters.)

(6) The large excess of dominants in the progeny of selfed hybrid plants. (Influence of the prepotent grandparent.)

(7) The constancy of a selfed homozygous dominant, compared with a hybrid. (The former is prepotent.)

(8) The constancy of a selfed recessive compared with a hybrid. (The pure-bred has greater transmitting power.)

If, then, the breeder of improved plants uses pedigreed lines (centgener plots, or ear-row tests) instead of mixed cultures, and selects in each generation the plants which are most prepotent *for the particular characters* he needs, he can, I think, usually leave Mendelian formulae to those who are working to discover new facts.

John Belling,
Florida Agricultural Experiment Station.

MATERIAL FOR PLANT BREEDERS

MODERN plant breeding proceeds on two principal lines: first, by confining itself altogether to present commercial varieties and trying to improve them, usually by some form of selection; second, by the use of new forms, which may be either developed on their own merits, or combined with existing commercial strains through hybridization. The first method has preponderated during the last half century, but breeders at present show a tendency to adopt the second method in larger numbers every year. In the United States they probably find their greatest aid to this end in the Office of Foreign Seed and Plant Introduction, of the U. S. Department of Agriculture at Washington.

This office has just issued its Fourth Annual List of New Plant Introductions, in which about 300 species or varieties of plants and seeds which it has recently secured are succinctly described in an accurate and understandable way. This material is available now or will be later available to any bona fide breeder who has proper facilities for making good use of it.

Much of it, as the introduction to the list points out, is as yet little known even botanically, and quite unknown horticulturally, as far as the United States are concerned. The plants described have been imported from all parts of the world because it is hoped that, indirectly or directly, they may be of use to Americans. "They are introduced primarily for use by the Federal and State Experiment Stations of the country, but are available to such private experimenters as have the necessary facilities and are desirous of testing them, notwithstanding the fact that they are quite untried commercially.

"Since these plants must ultimately be grown by private individuals before their commercial success is assured, it may be well to point out that those private experimenters who test these problematical new plants are assisting in a very practical way in the plant introduction work of the country even though they are not paid for their work.

"It is often around the successful cultivation of a new introduction by some private individual that a new plant industry begins."

SOME OF THE FEATURES.

While the list is made up largely of plants hardly known by name to the American horticulturist, there are also many species of common economic plants, in which every breeder will take an interest, now that the great potential value of wild relatives of our cultivated plants is being widely realized. There are, for example, 10 species of Amygdalus inventoried, part of which are to be classed among peaches and part among almonds. Many of them are adapted to extreme climatic conditions, and may prove valuable in themselves, as well as for breeding. Similarly there are three promising species of Citrus, besides the rare *Eremocitrus glauca* or Australian Desert Lime, probably the hardiest of all the citrous fruits. The persimmon genus, Diospyros, which has lately been attracting a good deal of attention from American breeders, is represented in the list by three species, while eight species of Malus will attract the numerous apple growers who are seeking new "creations." There are four promising species of Olea, the olive genus, 10 of poplar, some of which can hardly fail to be of value in the treeless regions of the Northwest, 12 of Prunus, including several hybrids, and 11 of willow. To cite even a fair selection of the isolated novelties would require too much space, but mention may be made of an edible chrysanthemum from China, the leaves of which are said to be a good substitute

for kale and spinach; the Indian coral tree (*Erythrina arborescens*), whose 12-inch spikes of brilliant scarlet blossoms remind one of the peerless Royal Poinciana, but which has the advantage of greater hardiness; the romantic Hawaiian Cotton Tree (*Kokia rockii*) which apparently was saved almost by chance from absolute extinction a few years ago; the handsome *Persea borbonia* of the southern United States, which may be of value to breeders of the avocado; an elm (*Ulmus densa*) from Turkestan, which should successfully withstand the alkaline soil and arid climate of the Southwest; and the large collection of melons from all parts of the world, any one of which may prove to be a prize in some locality adapted to it.

Any person interested in plant breeding, and willing and able to make use of novelties, should communicate with the Office of Foreign Seed and Plant Introduction, stating the amount of land at his disposal, whether owned or leased, whether plants are desired for greenhouse or indoor culture, and his experience in caring for and experimenting with plants. He will then be placed on the mailing list of the office, and be furnished with any of its material that he is able to utilize profitably.

Wheat X Rye Hybrids

Hybrids between wheat and rye are described by Fr. Jesenko in the Ztschft. f. ind. Abstammungs und Vererbungs-Lehre (X, 311-326). They are possible only when wheat is used as the seed-bearer or mother plant. From 6,100 pollinations the experimenter secured 35 heads of grain, which proved to be self-sterile. There appears to be blending in some characters and prevalence or dominance in others. These hybrids when crossed back on rye produced with one exception, nothing, when crossed back on wheat set grain in about 3% of the cases. The product of this cross was diverse; in general it much resembled wheat and the plants which seemed closest to wheat in appearance were in general the most fruitful. The one grain secured in the back cross on rye produced a plant strongly resembling rye

A Department of Eugenics

The *Red Back Texas Medical Journal*, published at Austin, now includes a "Department of Eugenics," edited by Dr. Malone Duggan and Dr. Theodore Y. Hull, both of San Antonio. It is devoted principally to sex hygiene and other sanitary measures.

Race Regeneration and Law

If even the problem of the extirpation of the feeble-minded classes can be approached and largely settled on a voluntary basis, without any risky experiments in legislation, much more is this the case with the higher breeding of the race, as it may be exercised by the fully sane and responsible classes. Here is emphatically the field of the moralist, who need not feel called on to forfeit his claim to being called a moralist by clamoring for the brute force of law. Even if scientific opinion and general public opinion were ready for marriage legislation in the interests of the regeneration of the race it would still be a problem how far such legislation is likely to be in accordance with sound morals. For legislation can only demand actions that are both generalised and externalised, and the demands of the regeneration of the race must be both particularised and internalised, or they are meaningless and even void. The law may, for instance, enact prohibitions against certain kinds of people marrying, but it cannot so prevent procreation, and the mere prohibition to marry is both unjust and unnecessary in so far as it prevents the unions of people who may be fully aware of their racial disabilities and consequent responsibilities and ready to act accordingly. Thus it is that morals is called upon to retain jealously within its own sphere these aspects of racial regeneration, and to resent the encroachments of law.—Havelock Ellis: The Problem of Race-Regeneration (1911).

NEW PUBLICATIONS

SEX: ITS ORIGIN AND DETERMINATION, by Thomas E. Reed, M. D.; 312 pages, $2.50. Rebman Company, New York, 1914.

In this well-advertised book the author, a physician, undertakes to supply some new conceptions concerning "The Nature of Life, Reproduction and Sex, the latent bisexuality of all animal life and the primitive hermaphroditism of the germ plasm; the nature and origin of twins, particularly of conjoined twins; the primitive alternating and metabolic nature of sex; the manifestations of lunar rhythms in labor, in infectious disease, their influence on births, deaths, surgical operations, menstruation, gestation and the determination of sex." Obviously a big job.

The thing that is new in the book is a theory that there is a cycle in animal life, of shorter duration than the well-known monthly cycle, manifested in the germ cells and the developed organism, and having an effect upon the determination of sex as well as on the progress of labor and other vital processes. The lunar day divided into two twelve hour periods, and these in turn divided into two six hour periods—a "positive" and a "negative"—supplies this cycle. A positive period—based on the position of the moon—is one during which the moon passes from the eastern horizon to the zenith, or from the western horizon to nadir. A negative period is one during which the moon passes from zenith to the western horizon, or from nadir to the eastern horizon. The theory further postulates that the ovum is alternatingly male and female, and that the sex that arises from it depends upon the stage the ovum happens to be in when fertilized. If fertilized during a positive period a male results; fertilization during a negative period produces a female. This the author claims practically to have established for the human subject.

The wonder is, however, that with so wide and extended a practice there were so few cases—about 20—to cite as evidence and that these were not all cited. And still greater the wonder that with all the energy spent in digesting literature and in deductive reasoning, the simple expedient of recourse to observation and experiment on animals—even domestic animals—was not resorted to. Here the whole theory of alternating hermaphroditism of the ovum and the author's general theory of sex determination would have been quickly disproved. Indeed, merely to have glanced in this direction—without further experimentation—would, as every biologist knows, have been quite conclusive. Whatever the inherent virtues of a tide-table, there is no reason to suspect that within it there lurks the sentence of sex.

OSCAR RIDDLE.

HEREDITY AND SEX, by Thomas Hunt Morgan, Ph.D., New York, Columbia University Press, 1913. Pp. xi + 282, $1.75 net.

This book of Dr. Morgan, professor of experimental zoology at Columbia University, is the standard authority on the relations between heredity and cytological research. It discusses in detail the recent microscopical studies of the cell and its chromosomes, and the Mendelian theories, as interpreting heredity, and particularly, of course, the inheritance of sex. The author considers as exploded the idea that external conditions determine sex, believing that it is determined through the internal mechanism of the cell itself, as a result of the laws of chance. He explains some of the contradictory results published by other experimenters by saying, "the environment may slightly disturb the regular working out of the two possible combinations that give sex male or female. Such disturbances may affect the sex ratio but have nothing to do with sex determination."

The
Journal of Heredity

(Formerly the American Breeders' Magazine)

Vol. VI, No. 2 February, 1915

CONTENTS

The Journal of Heredity is published monthly by the American Genetic Association (formerly called the American Breeders' Association) for the benefit of its members. Fifty per cent. of the annual membership fee is specifically designated as payment for the Journal. Canadian members who desire to receive it should send 25 cents a year, in addition to their regular membership dues of $2, because of additional postage on the magazine; foreign members pay 50 cents extra for the same reason. Price of single copies, 25 cents.

Entered as second-class matter August 27, 1912, at the postoffice at Washington, D. C., under the act of August 24, 1912.

Date of issue of this number, January 25, 1915.

A VALUABLE TOBACCO MUTATION

During the last 15 years the study of mutations has been popular, and many have been discovered, but few of them have been of economic value. This giant form of Connecticut Cuban tobacco, which suddenly appeared in a field of the Windsor Tobacco Growers' Corporation, and elsewhere, promises to add a large amount to the annual value of the crop in the state. It is breeding true and constant. (Frontispiece.)

[See "Tobacco Mutations," p. 73.]

WAR AND BIOLOGY

Militarism Can Not Be Justified by Appeal to Evolution and Natural Selection—The "Struggle for Existence" Misunderstood—The Present Responsibility of the Rural People.[1]

L. H. Bailey, *Ithaca, N. Y.*

EVERY great crisis imposes special obligations on the people; and certain classes or groups of the people may be met with separate phases of the obligation. So it is said that certain very definite responsibilities now rest on the farmer because of the upset of conditions produced by the great war.

In times of great stress, when the accessories of life and the unessentials are stripped from us, we come back suddenly to the necessities and to the bare problems of maintenance. If any durable good is to come to us as a people from the carnage in the Old World, one of the gains will be a quickened appreciation of our dependence on the essentials of the earth, and an accelerated determination to return to them as to the mother that gave us birth, and to the things that were ordained to us in the beginning. Every experience that brings us back to the munificence of the earth and to a conscious dependence on it, brings us back necessarily to the farmer, and he is elevated in the essential plan of any enduring human society. When the armies shall have killed each other off, when the supplies shall have been exhausted; when the military organizations shall have tired of their vanities, when vengeance has been spent, and when society becomes ashamed of itself, then we shall begin all over again at a slow and laborious process of reconstruction; and we must begin on the earth.

In these days of popular education, and particularly in this country where there are no organic social strata, the farmer should gain in relative position in society after every upheaval or devastation. He must make good the fundamental supplies. And for this reason, the farmer needs to prepare himself very well, that he may be a stronger citizen and better able to take his place. This, it seems to me, is the great message that you teachers are now to take to your people.

IMPROVING THE CROPS.

Much is said about the necessity of producing more crops and products because of the war. This is always the farmer's obligation. If this international slaughter quickens this obligation, as I think it will, the gain will be good and it will be real. I hope it will stimulate us all to do our best. There is just now abroad amongst us a teaching to the effect that the farmer cannot afford to put much additional effort into his crop-producing; there may be much truth in it; but it is a weakening philosophy: it is the farmer's ethical responsibility to society to increase his production; and if he is not remunerated, we must see to it, we all of us, that society so regulates itself as to correct the situation. It is specially important that the man at the bottom and in the background put forth his best efforts.

I hope that this demoralization will make us more self-resourceful. I hope we shall have more appreciation of our position on the planet, more care of our natural resources, more determination to do things that will stand, more understanding of the things that are worth while on the earth that is given to our keeping.

We are onlookers on the greatest carnage and the most wretched destruc-

[1] Parts of an address delivered before the nineteenth annual meeting of the American Association of Farmers' Institute Workers, Washington, D. C., November, 1914; and elsewhere.

tion of property that the world has seen. We are neutral. We try to see fairly, and to see all sides. This does not mean that we have no opinion. Quite the contrary; but it means that we do not take sides with any of the contending parties. There are at least three sides to this controversy: the side of the Teutonic allies; the side of the other allies; the side of the American or the outside observer. It is not my part to determine which side is right—if there is such a thing as right in a situation of this kind—but only to state one opinion and the reasons for it. It is my privilege to state an American point of view. Of course I might not hold this point of view if I were a national in either of the sides to the conflict.

RESPONSIBILITY FOR WAR.

Much effort has been expended to lay the blame for the starting of the vast war. But it is of little consequence who sprung the trap. The great fact is that the trap had been set.

It is a singular phenomenon, this effort to escape the responsibility. For years the military establishments have been glorified, and to be part in the establishment has been accounted the highest of honor. But now the responsibility must be explained away. Where, then, is the glory of war?

The effort to explain, to justify, to escape the responsibility, is a significant phase in this catastrophe. And every explanation only exposes the more the wretchedness of the situation.

We must not take to ourselves too much luster for our escape from the present destruction. We are not essentially different, only as we are more fortunately placed on the planet and as we have a more flexible political organization. We do not have the problems.

We are not to deny or even to overlook the great results that have come from war. Virile races have forced themselves to the front and have impressed their stamp on society; the peoples have been mixed and also assorted; lethargic folk have been galvanized into activity; iron has been put into men's sinews; heroic deeds have arisen; far reaches of the imagination have been opened. The state of human affairs has been brought to its present condition largely as the result of war.

On the other hand, we are not to overlook the damaging results, the destruction, the anguish, the check to all productive enterprise, the hatred and revenge, the thieving and hypocrisy and deceit, the miserable spy system, the loss of standards, the demoralization, the loss of respect and regard for the rights of the other, the thwarting of national and racial developments which, so far as we can see, gave every promise of great results. We naturally extol the nations that have survived; we do not know how many superior stocks may have been sacrificed to military conquest, or how many racial possibilities may have been suppressed in their beginnings.

NO JUSTIFICATION OF WAR.

But even assuming the great gains that have arisen from war, this is no justification of war; it only states a fact, it only provides a measure of the condition of society at any epoch. It is probable that war will still exert a mighty even if a lessening influence; and it may still be necessary to resort to arms to win for a people its natural opportunity; but this again only indicates the wretched state of development in which we live; and so long as this condition exists, every state must be ready for defense. Undoubtedly, also, a certain amount of military training is very useful, but we have striking evidence before us that a military establishment is also very dangerous. There should be other ways, in a democracy, to secure something of this needful training.

The final conquest of a man is of himself, and he shall then be greater than when he takes a city. The final conquest of a society is of itself, and it shall then be greater than when it conquers its neighboring society.

Man now begins to measure himself against nature also, and he is beginning to see that herein shall lie his greatest conquests beyond himself; in fact, by this means shall he conquer himself—

by great feats of engineering, by completer utilization of the possibilities of the planet, by vast discoveries in the unknown, and by the final enlargement of the soul; and in these fields shall be the heroes. The most virile and upstanding qualities can find expression in the conquest of the earth. In war, the rank and file do not rise to greater heights; but in the contest with the planet every man may feel himself grow.

What we have done in times past shows the way by which we have come; it does not provide a program of procedure for days that are coming; or if it does, then we deny the effective evolution of the race. We have passed witchcraft, religious persecution, the inquisition, subjugation of women, the enslavement of our fellows except alone enslavement in war.

THE STRUGGLE FOR EXISTENCE.

Here I come to a very real situation that I want to present to you as farmers and as teachers of farmers, to you who stand close to nature and who ought to understand the meaning of the natural world. I want to ask you to interpret to mankind what is implied in the struggle for existence; for war is justified as a necessary part of the nature of things, as all organisms must struggle in order to live.

Before I enter on this subject, I must pause to say that I would not of myself found an argument either for war or against it on the analogies of the struggle for existence. Man has responsibilities quite apart from the conditions that obtain in the lower creation. Man is a moral agent; animals and plants are not moral agents. But the argument for war is so often founded on this struggle in nature, that the question must be considered. I am making these statements only in the interest of a fair interpretation of nature and, I hope, for the guidance of ourselves.

It has been persistently repeated for years that in nature the weakest perish and that the victory is with the strong, meaning by that the physically powerful. I have heard such statements from boyhood. There can be no falser teaching than this, nothing that leads men farther from the truth. It is the result of an entire misconception of the teaching of evolution.

Our minds dwell on the capture and the carnage in nature—the hawk swooping on its prey, the cat stealthily watching for the mouse, wolves hunting in packs, ferocious beasts lying in wait, sharks that follow ships, serpents with venomous fangs; and with the poet we say that nature is "red in tooth and claw." Of course, we are not to deny the struggle of might against might; but the weak and the fragile and the small have been the organisms that have persisted. There are thousands of little and soft things still abundant in the world that have outlived the fearsome ravenous monsters of ages past; there were Goliaths in those days, but the Davids have outlived them, and Gath is not peopled by giants. The big and strong have not triumphed.

I was impressed in reading Roosevelt's "African Game Trails" with the great extent of small, and defenseless and fragile animal life that abounds in the midst of the terrible beasts—little, uncourageous things that hide in the crevices, myriads that fly in the air, those that ride on the rhinos, that swim and hide in the pools, and bats that hang in the acacia trees. He travelled in the region of the lion, in the region that "holds the mightiest creatures that tread the earth or swim in its rivers; it also holds distant kinsfolk of these same creatures, no bigger than woodchucks, which dwell in crannies of the rocks, and in the tree tops. There are antelope smaller than hares and antelope larger than oxen. There are creatures which are the embodiment of grace; and others whose huge ungainliness is like that of a shape in a nightmare. The plains are alive with droves of strange and beautiful animals whose like is not known elsewhere." The lion is mighty; he is the king of beasts; but he keeps his place and he has no kingdom. He has not mastered the earth. No beast has ever overcome the earth; and the natural world has never been conquered by force.

My friend went to a far country. He told me that he was most impressed with the ferocity, chiefly of wild men; and to him nature said, "eat one another." It came my time to go to that country. I saw that men had been savage—men are the most ferocious of animals, and the ferocity has never reached its high point of refined savagery until today. But I saw also that these savage men are passing away. I saw animals that had never tasted blood, that had no means of defence against a rapacious captor, and yet they were multiplying. Every stone that I upturned disclosed some tender organism; every bush that I disturbed revealed some timid atom of animal life; every spot where I walked bore some delicate plant, and I recalled the remark of Sir J. William Dawson "that frail and delicate plants may be more ancient than the mountains or plains on which they live;" and if I went on the sea, I saw the medusæ, as frail as a poet's dream, with the very sunshine streaming through them, yet holding their own in the mighty upheaval of the oceans; and I reflected on the myriads of microscopic things that for untold ages had cast the very rock on which much of the ocean rests. The minor things and the weak things are the most numerous, and they have played the greatest part in the polity of nature. So I came away from that far country impressed with the power of the little feeble things. I had a new understanding of the worth of creatures so unobtrusive and so silent that the multitude does not know them; and I remembered the prophecy that a little child shall lead them.

I saw protective colorings; I saw fleet wings and swift feet; I saw the ability to hide and to conceal; I saw habits of adaptation; I saw marvellous powers of reproduction. You have seen them in every field; you have met them on your casual walks, until you accept them as the natural order of things. And you know that the beasts of prey have not prevailed. The whole contrivance of nature is to protect the weak.

We have wrongly visualized the "struggle." We have given it an intensely human application. We need to go back to Darwin who electrified the phrase "struggle for existence" into life. "I use this term," he said, "in a large and metaphorical sense including dependence of one being on another, and including (which is more important) not only the life of the individual, but success in leaving progeny." The dependence of one being on another, success in leaving progeny—how accurate and how far-seeing was Darwin!

You know, you farmers, how diverse are the forms of life; and you know that somehow they live together and that only rarely do whole races perish by subjugation. You know that the beasts do not set forth to conquer, but only to gain subsistence and to protect themselves. You know that they do not pursue indiscriminately. You know that a henhawk does not attack crows or butterflies. Even a vicious bull does not attack fowls or rabbits or sheep. You know that the great issues are the issues of live and let live. You know that there are whole nations of plants, more unlike than nations of humankind, living together in mutual interdependence. You know that there are nations of quiet and mightless animals that live in the very regions of the mighty and the stout. And you know that you are glad it is so.

Reports For Sale at Low Price

Attention of members is called to the reduction in price of American Breeders' Association annual reports Nos. 6 and 7-8, announced on the inside back cover. In order to dispose of the stock it has on hand, and get the volumes into circulation where they will be of use, the association is offering them at one-half the price at which they were issued. This gives a unique opportunity to acquire two volumes of genetics literature at a very slight expense.

TWO CLASSES OF HYBRIDS

First Generation Differs Widely in Character from Second and Following Generations and the Two Classes Should Be Distinguished by More Exact Names, In Order to Avoid Confusion.

O. F. Cook

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THE use of distinctive names for the two principal classes of hybrids would be in the interest of convenience and intelligibility. The ordinal designations, "first generation hybrids," "second generation hybrids," "third generation hybrids," etc., are cumbersome and confusing in actual use. The Mendelian symbols "F_1," "F_2," "F_3," etc., serve for technical or esoteric writing, but are awkward typographically and have little meaning for the general reader. Both of these systems of designation are essentially misleading to the student, in that they leave out of account the biological differences between the so-called first or F_1 generations of hybrids and the second and later generations.

THE NATURE OF CONJUGATION.

Radical differences between first generation hybrids and later generations of the same stocks seemed altogether mysterious to the earlier investigators of heredity, but now are looked upon as necessary consequences of the specialized methods of reproduction followed by the higher plants and animals. The older idea of conjugation as a brief period of cellular fusion applies to some of the lower forms of life, but not to the higher. It is only among the lower organic types that the cellular body is built up in the interval between the completion of one conjugation and the beginning of another. In the higher groups the cells multiply chiefly during conjugation, that is, while the cells remain in a state of sexual fusion. The fusion that begins with the germ-cells, and gives rise to the new individual, does not cease when the growth of the new individual begins, but continues throughout its development. Beginning with the subdivision of the conjugating germ-cells, all of the cells that form the bodies of the higher plants and animals are double, with respect to their nuclear elements. Either there are two separate nuclei in each cell, or the two parental sets of chromosomes remain separate inside of the nuclei. The concluding stage of conjugation is mitapsis or fusion of the chromatin material, which finally arranges itself in the form of two long parallel threads. Conjugation is not concluded in the somatic cells, but only in the reproductive cells, as a preliminary to the formation of the next generation of germ-cells.[1]

NAMES OF THE CLASSES.

The usual object of experiments with hybrids is to analyze and recombine the characters of the parental types, and for this purpose at least two generations must be produced. As the so-called first generation of a hybrid is developed while the conjugation begun by the parental germ-cells is still in progress, it can be described as the conjugate generation. The so-called second or F_2 generation is really the first generation that can be considered as a complete product of the conjugation that was begun by the original germ-cells. The name perjugate seems appropriate because the nuclear elements represented in the second and later generations of a hybrid may be said to have passed through conjugation. Conjugate means

[1] Cook, O. F., and Swingle, W. T., Evolution of Cellular Structures, U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 81, 1905. See also, Proc. Washington Academy of Sciences, Vol. IX, pp. 191-197, 1907.

yoked together, perjugate through the yoke. In conjugate hybrids we see the results of prolonged partial conjugation, in perjugate hybrids the results of previously completed conjugation.

DIFFERENCES BETWEEN THE CLASSES.

When the original germ-cells are so different that conjugation cannot be completed, no normal germ-cells are formed by the conjugate generation, and no perjugate generation follows. The fact that it is often possible to secure conjugates from hybrid combinations that do not produce perjugates is itself an evidence that the two generations represent different phenomena of reproduction. The conjugate generation usually shows a general increase of vegetative vigor over the parental stocks, while perjugates are often weak or defective. Another general difference is that the individual members of a conjugate generation are usually alike, while the perjugates of the same stock are often very diverse. Thus when two distinct types of cotton are crossed the conjugate hybrids are as uniform as the members of the parent stocks, or even more uniform, but in the perjugate generations a wide range of characters may be shown, extending beyond the parental types as well as between them. The uniformity of the conjugates may be ascribed to the fact that the nuclear elements derived from the parent germ-cells are not fused or redistributed, but are merely associated in the same cells, much as different stocks may be united by grafting. The diversity of the perjugates indicates that the nuclear elements have formed more intimate and varied combinations.[2]

In view of these essential differences it is evident that the two classes of hybrids must be formally recognized before any useful generalizations can be framed. Of hybrids or of hybridization as a whole, little or nothing can be said that is not erroneous or misleading. All of our general statements regarding the nature, behavior or agricultural value of hybrids relate to one of the two classes, instead of to both. Conjugate hybrids are of use chiefly in plants that are adapted for vegetative propagation, while seed-propagated varieties must be secured by selection from perjugate generations. Conjugate hybrids are useful in some crops, perjugate hybrids in others. In each experiment the conjugates may be expected to show one series of biological phenomena, and the perjugates another, contrasting series. For all scientific and practical purposes it is necessary to keep in mind the differences between the two classes of hybrids, and this would be easier if distinctive names were employed.

[2] The nature and extent of the diversity that has been observed in cotton may be judged from the photographs accompanying the more detailed paper on Perjugate Cotton Hybrids by Charles G. Marshall.

A Race Betterment Exhibit

Desiring to render concrete some of the positive suggestions made at Battle Creek in January, 1914, the Race Betterment Fund (which has recently received a permanent endowment of $300,000) is arranging for a Race Betterment Exhibit in the Educational Building of the Panama-Pacific Exposition at San Francisco. The keystone of the exhibit will embody the constructive and practical methods of race betterment, viz.: preventive medicine, social and personal hygiene, child and civic welfare agencies, practicable eugenic suggestions, etc., but a certain amount of space will be devoted to the causes and evidences of race degeneracy. The Eugenics Record Office will not have an exhibit as it had planned.

PERJUGATE COTTON HYBRIDS

Amazing Diversity Characterizes Second Generation After Cross, and Affects All Characters of Plants, While First or Conjugate Generation Shows Great Uniformity.

CHARLES G. MARSHALL

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DIVERSITY in the perjugate generations of cotton hybrids must be a familiar phenomenon to all who have made the experiment of crossing two distinct types of cotton. It has been shown in numerous crosses that have been made between the Egyptian cotton and a series of Upland varieties. One of the most conspicuous examples was afforded by a series of hybrids between the Egyptian cotton and the so-called "Hindi" cotton, an inferior type chiefly known as a contamination of the Egyptian crop. The experiment of making artificial crosses between the Egyptian and Hindi cotton was not made with any idea of securing superior varieties but in order to learn the range of diversity in the Egyptian stock that might be ascribed reasonably to contamination with the Hindi cotton. The results showed that a very wide range of diversity could be induced by hybridization. With the advice of O. F. Cook detailed notes were made on a series of plants as a means of recording the nature and extent of the diversities that appeared among the perjugate hybrids.[1]

In 1910 self-fertilized bolls of a conjugate hybrid plant of Hindi x Egyptian cotton were secured by A. McLachlan, and in 1911 the seed was planted at Bard, California, in order to observe the behavior of the second or perjugate generation. Conjugate hybrids between the same stocks were raised in adjoining rows, and the essential differences between the two generations were shown in a very conspicuous manner. Members of the conjugate generation were not only uniformly alike but showed characters intermediate between the two parent stocks. The perjugates, however, were so diverse that no two plants could be found with even a few of their characters alike. Many of the plants would not have been associated with either of the parent types, if their parentage had not been definitely known. Parental characters were not only exaggerated but in many cases entirely new characters were developed.

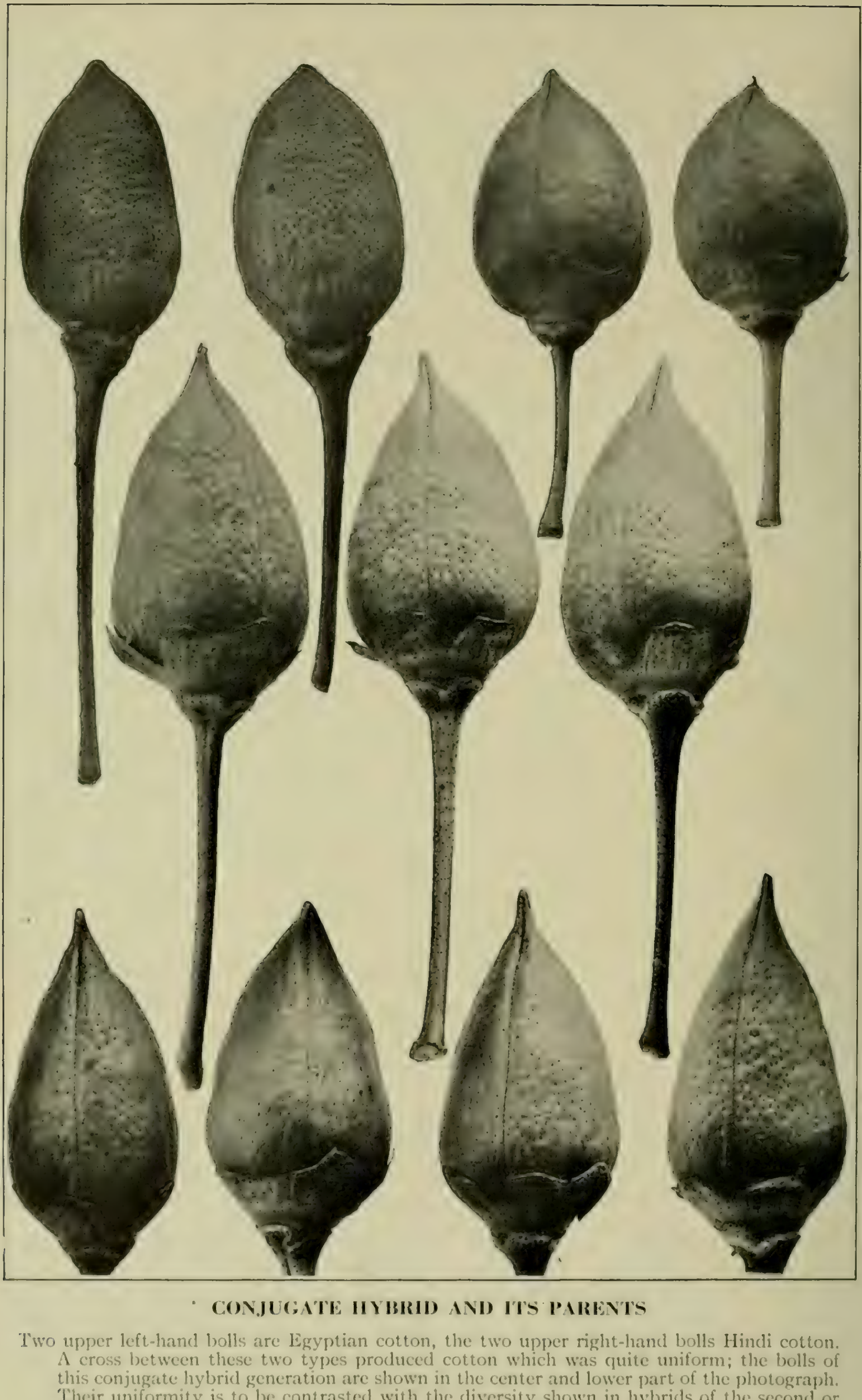
EXTENT OF DIVERSITY.

Even in their general appearance and behavior the perjugate plants showed a most remarkable range of diversity. There were all degrees of size, coloring, habit of growth and earliness of maturity. One plant might be large, light in color, strong and upright and late in maturing and the next plant in the row be small, dark in color, weak and drooping and early in maturing. Yet such completely contrasted plants might be full sisters, grown from seed of the same self-fertilized boll.

DIFFERENCE IN LEAVES AND BRACTS.

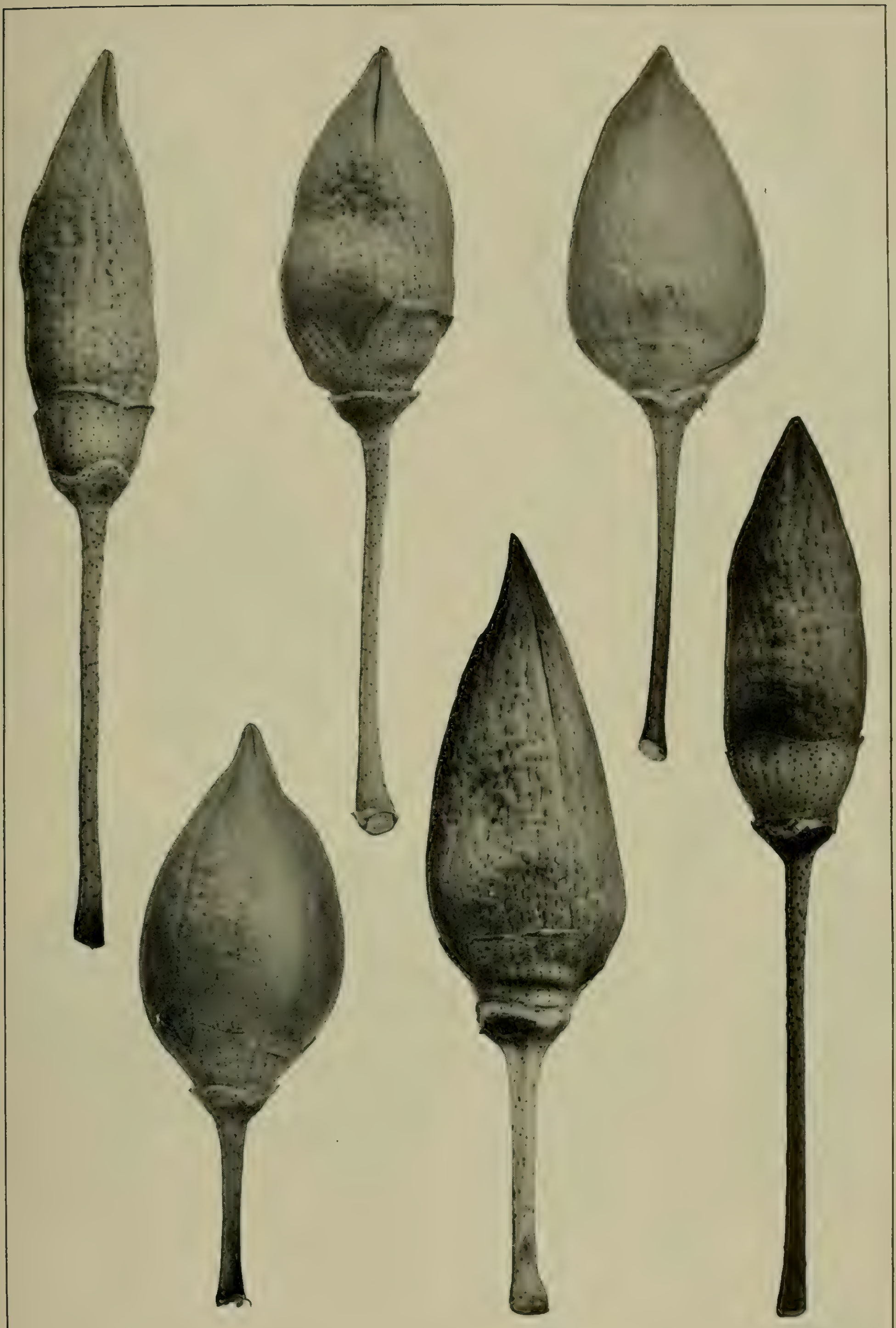
Studies of the different parts of the several plants such as the leaves, involucral bracts, bolls and seeds, revealed as great diversity and range of differences among these more detailed characters as there was in the general appearance and habit of growth of the plants. Many combinations of these characters were to be found in the different plants but no two plants were found that appeared to have the same combination, nor was it possible to

[1] Cook, O. F., Hindi cotton in Egypt, U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 210, 1911, and Heredity and Cotton Breeding, Bulletin 256, 1913.



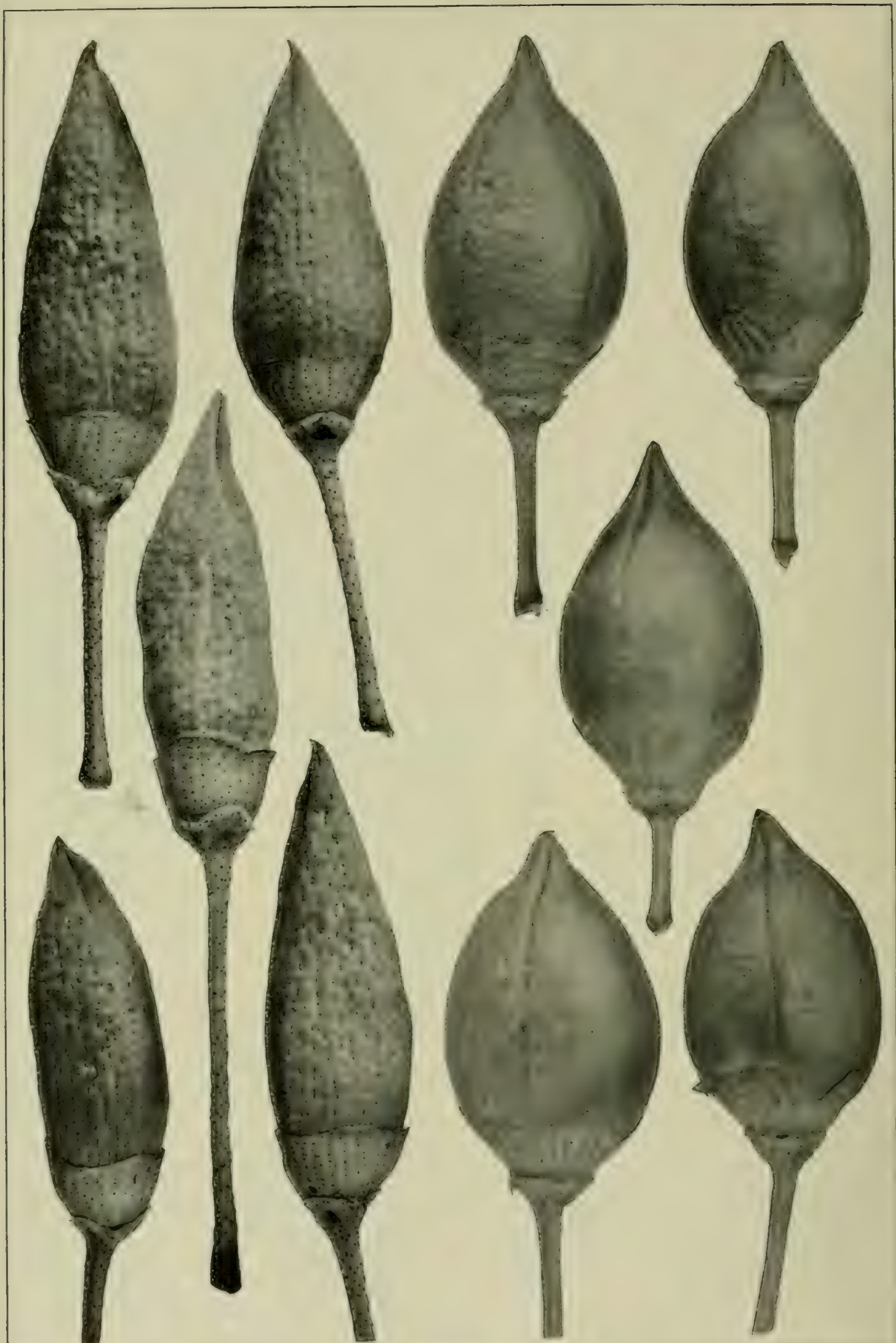
CONJUGATE HYBRID AND ITS PARENTS

Two upper left-hand bolls are Egyptian cotton, the two upper right-hand bolls Hindi cotton. A cross between these two types produced cotton which was quite uniform; the bolls of this conjugate hybrid generation are shown in the center and lower part of the photograph. Their uniformity is to be contrasted with the diversity shown in hybrids of the second or perjugate generation, as exhibited in the following illustrations. Photo natural size. (Fig. 1.)



BOLLS OF PERJUGATE HYBRIDS

They represent the second generation from a cross of Egyptian and Hindi cottons. The six specimens represent six consecutive sister plants raised from seeds from the same boll of the conjugate parent, produced from a self-fertilized flower. Compare the diversity of these bolls with the relative uniformity shown by the conjugate generation in the preceding illustration. Photograph natural size. (Fig. 2.)



BOLLS OF PERJUGATE HYBRIDS

Five bolls from each of the first two sister plants represented in fig. 2, the progeny of a cross between Egyptian and Hindi types of cotton. By comparing the left-hand side of the plate with the right-hand side, a vivid impression of the nature and extent of differences of boll characters among perjugate hybrids can be gained. Photograph natural size. (Fig. 3.)

discover any general correlations or definite associations between any of the more important structural differences.

The leaves of the different plants varied in color from a light or yellowish green to a very dark green, some of the plants showing a bronze or reddish tinge. They also varied in shape from simple leaves to leaves with deeply cut lobes, with margins wavy or crenate in many different degrees. There was the same variation in the glossy or hairy surfaces, as well as in texture and veining; in fact the leaves of sister plants were often so different that they might well have represented as many distinct types of cotton.

Figure 4 gives an idea of some of the differences and peculiar characteristics of the involucral bracts of five of the perjugate hybrid plants. The bracts not only differed in size, shape, texture and coloring, but many of them revealed in their position around the boll new traits entirely foreign to either of the parent stocks. In one case the bracts performed a peculiar twist at the ends, leaving the boll exposed and giving the appearance of a toy pinwheel, especially if viewed from above. The bracts of another plant were very large and concave or inflated, completely enclosing the bolls.

DIFFERENCES IN BOLLS AND SEEDS.

The extra-floral nectaries, which are one of the specialized features of the cotton plant, also showed many aberrations, and sometimes marked degeneration. The general tendency seemed to be toward a smaller development of nectaries than in the parent stocks. On the majority of the plants the nectaries both of the leaves and involucres were very small and inactive or altogether absent. One plant, however, had very large and active nectaries, larger than is customary with either of the parent stocks. Another plant had one active nectary on the midrib of the leaf and the nectaries inside the involucral bracts were large and active, but those on the outside of the involucral bracts were inactive, and often lacking altogether.

The bolls of these perjugate hybrids were perhaps more striking in their diversity and possession of strange characters than any other parts of the plant. There were many shapes, some very unusual and freakish. The bolls of one plant were very long and narrow, almost cigar-shaped. Another plant had bolls almost round but with a beak as long as, and in many cases longer than, the body of the boll. Still another plant had small bolls with blunt ends and a constriction at the middle which made them look like peanuts. Some plants had large bolls and some small, some had bolls dotted with numerous oil glands and some with few, some plants had bolls deeply pitted and some had bolls with smooth surfaces, the oil glands being more deeply buried in the tissues of the wall.

The seed and lint characters were as diverse as the boll characters. The seeds from the different plants were of many sizes and shapes and no two plants showed the same distribution of fuzz on the seed. The seed of one hybrid plant was entirely naked while usually there were tufts of fuzz at either the apex or base of the seed or at both ends, these tufts varying in size for the different plants. Several plants had the seeds completely covered with thick fuzz, but even these differed from each other in that some had green fuzz, some brown and some pure white. The lint also varied greatly in both quantity and quality and ranged in color from a pure white to a decided buff. From a commercial standpoint the lint would have been of little value because of the variation in length and quality of the lint from the different plants.

A few descriptions of individual Hindi-Egyptian hybrid plants of the perjugate generation may help to show how diverse they were, and how in many cases their characters ranged beyond either of the parent stocks. The plants here described were grown from self-fertilized seed of one conjugate Hindi x Egyptian plant. The first six plants were grown from seed of one boll, the next three from another boll and the last three from a third boll. No attempt is made to cover all the

BRACTS OF PERJUGATE HYBRIDS

Involucral bracts of the perjugate hybrids between Egyptian and Hindi cottons, representing five of the sister plants shown in fig. 2. Note the difference in form, size, position and texture of the bracts. Photographs natural size. (Fig. 4.)

SEEDS OF PERJUGATE COTTON HYBRIDS

The 12 groups represent 12 sister plants of the second generation from the cross of Egyptian and Hindi cottons. The first six are the same plants represented by the bolls in fig. 2, the next three are from another self-fertilized boll of the same mother-plant, and the last three are from still another boll of the same mother plant, also self-fertilized. In addition to the differences in size and shape of seed and in texture and distribution of fuzz, these seeds differed in the color of the fuzz and the length, color and quality of the lint. Natural size. (Fig. 5.)

points of difference, but merely to state the features in which the plants differed most noticeably from each other and from the parental types.

INDIVIDUAL PLANTS.

No. 1. Plant large with heavy foliage and reddish branches; leaves large, slightly crenate with well developed active nectaries. Involucral bracts with a reddish tinge, medium sized, triangular, joined slightly at the base and lying close to the boll. Bolls large, irregular in outline, long and tapering from broad base to a tapering beak at the end, deeply but not closely pitted with oil glands. Seeds nearly naked with small tufts of fuzz at both ends.

No. 2. Plant medium sized, and light colored. Leaves glossy, very slightly crenate, with nectaries lacking or inactive. Involucral bracts very large with long irregular teeth. The bracts concave and inflated, completely covering the boll. Shape of bolls much the same as those of No. 1, but smaller and fuller, smoother, and more glossy, with more oil glands. Seeds large, round with thick green fuzz.

No. 3. Plant large and light colored, with slim weak branches. Leaves large, with slightly crenate margins and one active nectary on the midrib. Involucral bracts coarse in texture, long and triangular, strongly twisted to one side, thus leaving the boll exposed. Bolls narrow oblong, very long and slim, deeply pitted and with no gloss. Seeds long and nearly naked, but with small tufts of fuzz at both ends.

No. 4. Plant large and luxuriant, with dark foliage. Leaves decidedly crenate, and more hirsute than those of preceding plants. Involucral bracts large, with coarse teeth, triangular and not cordate at the base but joined together for a half inch. Bolls of medium size tapering from above the middle, to a short point, and intermediate in color with numerous oil glands, glossy and smooth. Seed small, round, nearly naked, with small tufts at both ends.

No. 5. Plant large, strong and vigorous, but very late in maturing. Leaves large, upright, crenate, light in color, with dull surfaces and small nectaries. Involucral bracts rather small, triangular, scarcely cordate at the base, and but slightly joined. Bolls conical oval, full, very glossy, numerously dotted but not deeply pitted with oil glands. Seed rather long, nearly naked, with very small tufts at both ends.

No. 6. Plant small, dark in color, very productive and early in maturing, in many respects exactly the opposite of No. 5. Leaves small, glossy with straight, even margins, broad and not as deeply lobed as preceding plants; but one nectary on leaves, but that large and active. Involucral bracts small, triangular with even teeth, neither cordate nor joined at the base. Bolls small, almost round, with a short, rather blunt beak, glossy and numerously dotted but not deeply pitted with oil glands. Seeds small, nearly naked, with no tufts of fuzz.

No. 7. Plant very large with many vegetative branches and no fruiting branches developed for four feet up the main stalk. Leaves large, with broad lobes very slightly cut and very often simple. Leaves light in color, but with a bronze tinge and very glossy. Bracts very small, round, evenly toothed and lying close to the boll, bronze in color. Boll of medium size, round, full, tapering abruptly into a thin pointed beak, dark, glossy and abundantly and deeply pitted with oil glands. Seed large, round, covered with thick white fuzz.

No. 8. Plant tall and dark in color. Leaves small and strongly crenate, dark and glossy, showing but one nectary. Bracts small, triangular, not cordate at the base but joined, with a copper tinge. The ends of the bracts twist to the side, thus leaving the boll exposed. Bolls like those of plant No. 7. Seeds large, round and nearly naked with a large heavy tuft at base.

No. 9. Plant tall and weak with red drooping branches, very productive and early in maturing. Leaves large, with deeply cut lobes, light in color, not glossy. Bracts of medium size, more round than triangular, with teeth curving outward. Their special feature is that they are strongly concave or inflated, forming a balloon-like enclosure around the boll. Bolls of medium size, long, tapering gradually from the middle to a beak, light in color, the surface rough and deeply pitted with oil glands. Seeds small, covered with thin fuzz and a small dense tuft at base.

Plant 10. Plant medium sized, sturdy and early in maturing. Leaves of medium size, light in color, not glossy, not crenate and almost square in shape with two or three well developed nectaries. Bracts medium sized, reddish, round, slightly inflated and inclined to twist to one side at the ends, very cordate at the base, but not joined. Bolls medium sized, oval tapering to a blunt beak, light in color, glossy with few oil glands. Seeds large, angular and covered with greenish fuzz.

Plant 11. Plant small, dark in color and early in maturing. Leaves medium sized, broad, with narrow sharp lobes, the margins strongly crenate, the leaf nectaries present and active. Bracts very small, triangular with short teeth, the division of the three teeth at the end of the bract showing plainly, slightly cordate and joined at the base. Bolls small, tapering abruptly from below the middle to a blunt point, light in color, not glossy, with few oil glands. Seed medium sized, angular, nearly naked, with very small tuft at base.

Plant 12. Plant small and weak, light in color. Leaves intermediate in size and color, but slightly crenate. Bracts small, with a reddish tinge, round, with short teeth, slightly cordate, but not joined at the base. Bolls large, tapering from the middle into a blunt beak, light in color, smooth, glossy, full, oval. Seeds large, plump and completely naked.

E. S. CARMAN

One of the Greatest of American Plant Breeders—His Work Too Little Appreciated—Success With Potatoes Most Noteworthy—His Activity as a Journalist.

E. M. East

Bussey Institution, Forest Hills, Massachusetts.

IT IS a delightful epigram but hardly the actual truth that "If a man preach a better sermon, write a better book, or build a better mouse-trap than his neighbor, though he hide himself in the wilderness, the world will make a beaten path to his door." The world as a whole is likely to give its applause to some very unimportant people. And after all is it not probable that too general a commendation encourages superficial rather than solid work? The anti-socialistic argument that a more even distribution of earthly comforts would oppose progress because it limits ambition is a pure sophism. Few things worth doing have been done with either money, power or fame in view. For this reason there is no need to feel sorry that E. S. Carman, great alike as agricultural journalist, public spirited citizen and creator of new varieties of plants, never received the panegyrics of which some others have been since the recipients. He had the happiness described by Marcus Aurelius: "A man's happiness—to do the things proper to man." Not that Mr. Carman was unknown—perhaps the editor of no rural paper was admired and trusted more—but, even with the temptation of a private medium for exploiting his triumphs, he did no more than describe carefully and impartially success and failures alike with the honesty of a true nature-lover and born investigator.

Mr. Carman would probably have denied that he was a great plant breeder. He originated no new methods and made few contributions to the study of heredity; but he did discover many interesting facts during his hybridization experiments and he added hundreds of millions of dollars to the wealth of the country, keeping nothing for himself. He was a national benefactor, and who will say he was not a great man when he placed public service before private gain? His attitude in the matter is summed up in the final paragraph of an article on the five famous potato varieties placed on the market between 1882 and 1896. "It will now appear that for our 16 years of potato work, we have sold five kinds for precisely $1,000. We dare say that, had we used our columns for advertising the three kinds now offered for sale, retaining the entire control as long as possible, *The Rural New-Yorker* might easily have made a snug little fortune. But, tell us friends, were we to crack up the plants that have originated at the "Rural Grounds" while we sold them to you either directly or indirectly, do you think that you would place as much confidence in the thorough impartiality of our plant reports, as you do now?" Ten years ago the writer made a trip through the great potato regions of Wisconsin and Minnesota. During it one of the most successful and best informed growers stated that in the previous decade 80% of the potatoes of the country were either Mr. Carman's productions or seedlings from them. How much truth there was in this statement it is impossible to say, but discount it as much as one will, can it be said that there is no such thing as altruism?

POTATO CREATIONS.

The famous potatoes from the Rural Grounds were Rural Blush, Rural New-Yorker No. 2, Carman No. 1, Carman No. 3 and Sir Walter Raleigh. They

were not raised from hand hybridized seed, though this had been the original intention. Sixty-two varieties were grown as prospective parents, but crossing proved impossible; no functional pollen was formed. A few natural seed berries were found, however, and from them after years of testing these five kinds proved to be the fittest. Even the records of the maternal parents were lost, but the goal set at the beginning was reached. New potatoes better than the old Early Rose and Peachblow were produced. Considering the amount of time and space at command, it was probably the most successful practical plant breeding experiment ever tried.

In all of the other hybridization work, Mr. Carman made careful castrations of the flowers used as female parents, protected the blossoms from foreign pollen and made the crosses by hand. "Guess work in hybridization or crossing," he says, "is altogether abominable, because it is impossible to know whether anything has been effected or not, while the variations sure to appear in the seedling plants, it will be assumed, are evidences of cross-bred parentage."

One of the most interesting pieces of work brought to a successful conclusion, was a cross between the beardless Armstrong wheat and rye made in 1882. Several varieties from this cross were finally introduced, but whether they battled successfully with pure wheats or ryes, I have never heard.[1] The important thing was the variation in a first hybrid generation which was conclusively demonstrated—work which it would be interesting to repeat even now as the constancy or comparative homozygosity of the parents was unknown—and the pioneer work of showing the possibility of making crosses between these two generically different cereals. Mr. Carman saw the salient point very clearly as the following quotation shows: "What do they promise? If the hybrids give us a grain less valuable than rye or wheat, nothing will be gained in this case, except the curious fact that a cross between two different genera of grain is possible. This established, however, the way is opened for further hybridization the pregnant results of which can only be guessed at."

Another interesting specific cross made by Mr. Carman was between the blackberry and the raspberry. It gave nothing of commercial importance, though by repeating it Luther Burbank is said to have produced a valuable berry. Neither Mr. Burbank nor Mr. Carman, however, was the first to make this cross; Mr. Carman, himself, admits obtaining the idea from William Saunders of London, Ontario, who had produced similar hybrids some five years before.

WORK WITH SOLANUMS.

Mr. Carman's taste evidently was partial to the Solanaceæ. He worked for many years on tomatoes, and succeeded in isolating from his various crosses five types that were worthy of introduction to the trade. They were the Longkeeper, Lemon Blush, Terra Cotta, Autocrat and Democrat. Autocrat and Lemon Blush were known for years as the finest of their kind. He also crossed the common tomato with both the Currant Tomato *L. pimpinellifolium* and the nearly related genus Physalis. Whether any valuable types were produced from the first cross or not, I have been unable to find out, but it was demonstrated that the first hybrid generation was intermediate in character and that a few of the individuals of the latter generations combined a fairly large size of fruit with the racemic type of inflorescence. The generic cross was not sufficiently fertile to be propagated, and died out after a couple of generations.

Various other crosses of all kinds kept up the interest of Mr. Carman in his work, in which he was efficiently and enthusiastically aided by Mrs. Carman,

[1] W. Van Fleet, who was associated with Mr. Carman in his breeding work, states that none of the real hybrid types survived continued propagation. Segregation occurred to such an extent that the progeny soon became, to all appearances, either rye or wheat. None of the rye types proved of particular value, but several of the wheat types are still in use. Farmers Bulletin No. 616 of the U. S. Department of Agriculture, "Winter Wheat Varieties for the Eastern States," recommends the soft "Rural New Yorker No. 57," one of Carman's creations.—The Editor.

although with one exception the rose hybrids were the only ones that were extremely valuable. This was the Carman Gooseberry. Here was a gooseberry that might have revolutionized gooseberry growing since in a limited test it was mildew proof, but unfortunately the seed firm to which it was sold was unable to propagate it.

The roses were perhaps the real attraction of the "Rural Grounds." The *Rosa rugosa* of Japan was the foundation stock, and upon it were crossed first the Austrian hardy yellow rose known as Harrison's Yellow, then Hybrid Perpetuals and afterwards Hybrid Teas. From these crosses hundreds of plants were raised—most of them, of course, worthless, but some of remarkable beauty. From the first cross mentioned came the Agnes Emily Carman, a fine, hardy, longlived, though thorny variety. In color it was like the Jacqueminot, but many times as profuse in blossoming. From other crosses came procumbent roses, hedge roses, tea roses, etc., etc. They did not attain pre-eminence as did the potato varieties but they helped and still help to brighten many a flower garden.

Elbert S. Carman was born on November 30, 1836, in Hempstead, Long Island. He entered Brown University in 1854, rooming with John Hay. He was obliged to withdraw after two years of work, however, on account of illness. In 1873, he married Agnes E. Brown, by whom he had two children. Immediately after his marriage he moved to River Edge, N. J., where he began to plant and experiment on the place that afterward became so well known as the "Rural Grounds." While here he became so interested in Moore's *Rural New-Yorker* as a contributor, that he purchased the paper and became its editor in 1876. Through an absolutely open and honest policy, he made this journal a power in the agricultural world. For many years it has stood out against all frauds and impostures to the farmer, even though this went against its monetary interests. Mr. Carman died February 28, 1900, regretted by the many friends he had made in his editorial capacity, who wrote of him like the hero of Leigh Hunt's ever popular poem, "as one who loved his fellow men."

The Chromosome Hypothesis of Heredity

A working hypothesis of some sort is an essential tool of an advancing branch of experimental science. It behooves us in the study of heredity to use the best hypothesis we have, until it is replaced by a better.

The chief objections to the chromosome hypothesis, so far as I can gather them, are:

1. The English pioneer, Bateson, used instead the working hypothesis of somatic segregation.
2. The chromosome hypothesis does not appeal to physiologists and chemists.
3. The affairs of the chromosomes may be regarded as a consequence instead of as a cause.
4. Many of the changes of chromosomes and nucleus are still uncertain.
5. The chromosome hypothesis was discredited by Weismann's extensive and untested speculations

On the other hand, there are advantages in the use of the chromosome hypothesis.

1. Bateson's counter hypothesis of somatic segregation has proved barren, and appears to be contradicted by certain facts.
2. Strasburger's unrivalled experience found the chromosome hypothesis to fit the facts of plant cytology as well as those of inheritance.
3. The chromosome hypothesis fits the breeding facts of the Cambridge school even better than their own hypothesis.
4. It has been used as a fertile working hypothesis by Morgan and his fellow-workers in their unique experiments at Columbia University.
5. It seems to be coming more and more into use in accounts of research in plant breeding. It has, I think, no serious rival. Whether we like it or not, it appears to be here to stay.

It must be remembered that an experimenter does not usually question whether the hypothesis he uses is true or false, but whether it is useful or barren in leading to new experiments or connecting up facts. Working with it will soon show whether it is good or bad.

John Belling, *Florida Agricultural Experiment Station.*

JERSEY-ANGUS CATTLE

Cross Produces Diversity of Types and May Lead to Establishment of Valuable New Breed Which Will Combine Dairy and Beef Characteristics and Be Hardy.

Arthur H. Kuhlman

Department of Animal Husbandry, University of Wisconsin, Madison, Wis.

On his country estate near the little village of Thirsk in northern England, Frances B. Samuelson is making a practical application of Mendelian principles in producing a herd of cattle adapted to the conditions of that locality. Stockmen of northern England and southern Scotland claim that numerous attempts have been made to introduce the Jersey breed into those sections but apparently the Jersey is not able to adapt itself to the climatic conditions of this region and has failed to thrive. The strictly beef breeds do well, but according to Mr. Samuelson's ideas do not produce the desired quantity or quality of milk.

In trying to produce an animal that would fulfill all of these conditions, Mr. Samuelson began crossing Shorthorns and Jerseys, but as the subsequent offspring showed such a variety of colors, resulting in a decided lack of uniformity in the color markings of the herd, this cross was abandoned. About seven years ago the Jersey-Angus cross was begun. Five typical pure bred Jersey cows were mated with a pure bred Aberdeen-Angus bull. Five F_1 females (one of these is shown in Fig. 6) obtained from this cross were in turn mated with an F_1 bull. The F_2 heifers were then mated with an F_2 bull.

The F_1 generation has many of the outward appearances of the Angus, being black or dun in color, polled and rather beefy in conformation. Milk records of all the cows are being kept and the F_1 cows show a high yield of milk and butter fat, ranking almost as high as their Jersey dams. These cross-bred cows have very uniform and good sized udders and seem to be good dairy animals. They are also more hardy than their dams, requiring less close housing during the winter. In fact open sheds have been found to furnish sufficient protection for all the young stock and the warm stables needed to house the Jersey cows proved too warm for the cross-breds.

HIGH MILK PRODUCTION.

One of the F_2 cows (Fig. 7) in milk last summer when I saw the herd, was giving 30 pounds of milk daily which tested over 4% butter fat. During her first lactation period she produced 4,110 pounds of milk. She is a dark or brindled fawn having many dairy characteristics but is rather more beefy than a Jersey.

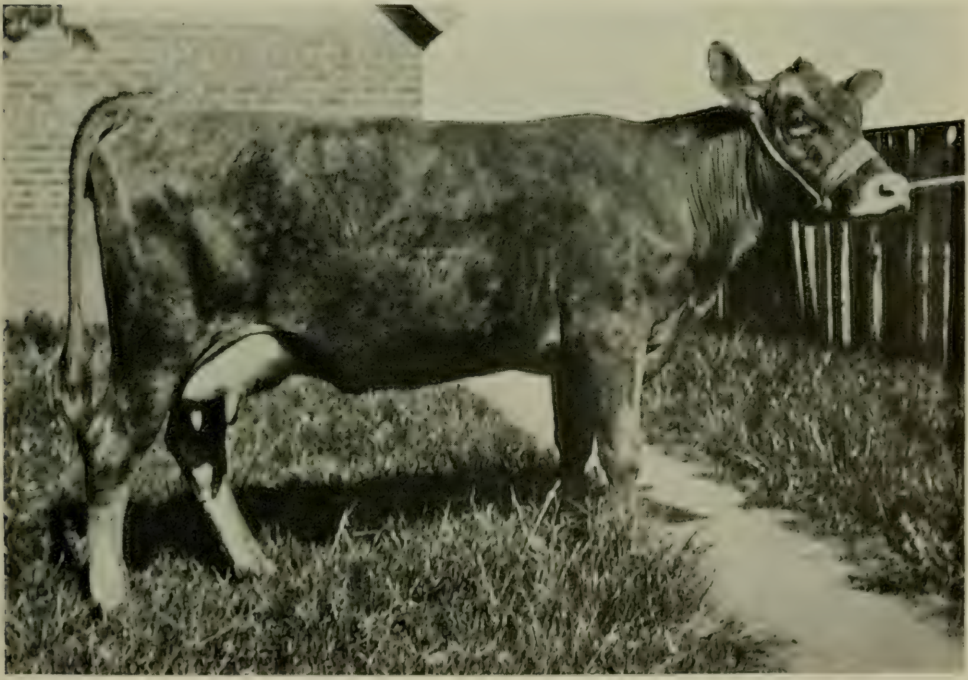
Sixty animals are numbered and entered in the herd records but only 20 are now in the herd, which at the present time consists of the following

2 Jersey cows.
6 F_1 cows.
2 F_2 bulls (Figs. 8 and 9).
8 F_2 females (see figs. 7, 10 and 11).
2 F_3 calves.

As stated above, all the F_1 individuals are black. Among the F_2 progeny four heifers and a bull are black like the F_1 individuals, one heifer is black with gray hairs on her face, a bull and a heifer are brindled fawn, and two heifers are very dark fawn with light fawn markings around muzzle, ears and inner thighs. Six of the F_2 heifers are distinctly polled like the Angus while two have a square poll like a heifer that has been dehorned. The F_2 yearling bull that has been selected as stock bull (Fig. 8), has many Jersey characteristics as regards form of head and body. He is perhaps more of the dairy than the beef type, is reddish

FIRST GENERATION JERSEY X ANGUS CROSS

A smooth neat cow with a good udder, who shows the characteristic poll of the Angus and is somewhat beefy. The breeder is attempting to combine the unrivaled milk yield of the Jersey with the hardiness and beef quality of the Angus. (Fig. 6.)



SECOND GENERATION HEIFER

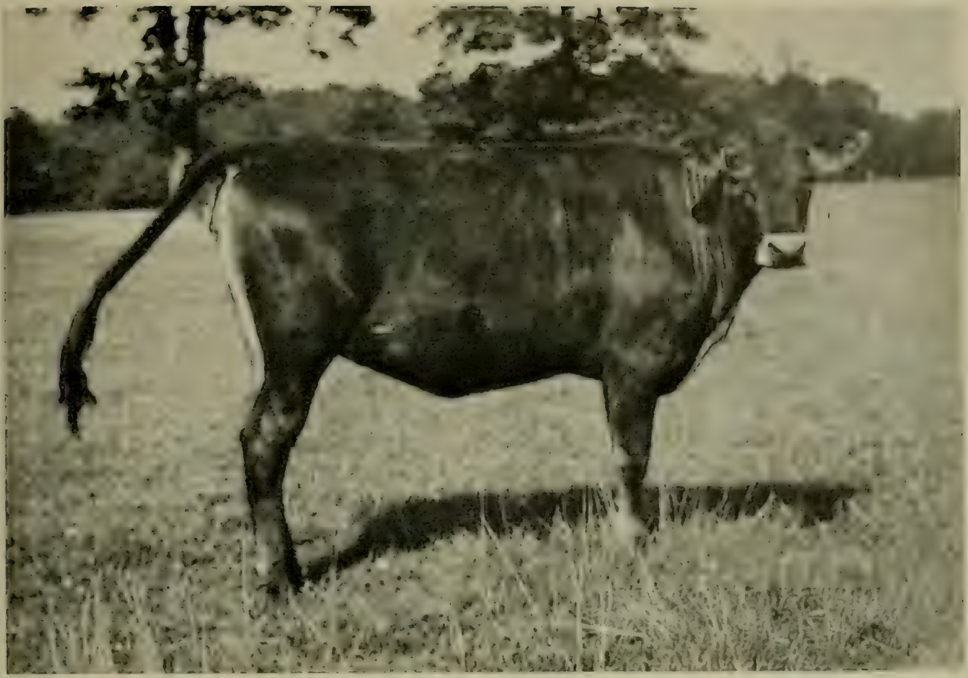
This cow, orange-fawn in color, shows "dairy form" and is proving a good producer. The fawn colors are preferred by the breeder, although many of the progeny of the cross have been black or dark. (Fig. 7.)

THE SIRE OF THE HYBRID HERD

Second generation bull of the Jersey x Angus cross. He is reddish fawn, slightly brindled, with a Jersey muzzle. (Fig. 8.)

ALMOST A TYPICAL ANGUS

Another second generation bull from the Jersey x Angus cross, who shows very few of the Jersey characteristics. Not being of the type desired by the breeder, he has been discarded in favor of one who shows fewer of the Angus traits. (Fig. 9.)



SECOND GENERATION HEIFER

One of the favorites in the herd. She has a light muzzle and inner thighs, while body is dark fawn. (Fig. 10.)

SECOND GENERATION HEIFER

Rather too smooth and beefy to meet the breeder's tastes. He is seeking a dairy strain first of all, and although he wants it to have beef qualities, he does not care to let the latter preponderate. (Fig. 11.)

fawn and slightly brindled and has a typical Jersey muzzle. He seems to be more red than any of the cross-breds obtained thus far. His poll is slightly rounded and while he is not hornless the scurs are very short and loose. The other F_2 bull (Fig. 9), is polled, jet black and could almost pass as an Angus. The owner does not favor this type and will hold him in reserve to be used in the herd only if it should become necessary.

While the F_1 generation shows much uniformity, the F_2 individuals show marked variations in conformation and color indicating a segregation and recombination of the characters of the original parents. This fact always needs consideration by one who is trying to develop a new breed. The following are some of the apparent types which have appeared in the second generation of this Jersey-Angus cross:

Black polled "Angus" type;
Black horned;
Black with indication of fawn, "Jersey" type;
Black and white, horned;
Orange fawn with light muzzle and polled;
Brindled fawn with dark muzzle;
Black with grey hairs in face.

Only those animals that are of the type that Mr. Samuelson likes are kept for breeding purposes. He prefers a dun or red fawn to a black color and does not like those that are too "beefy." He is working on this as a commercial proposition, but is keeping an accurate record of every animal, its performance and final disposition. Those cross-breds that are not used in the breeding herd are sold in the open market as Jersey-Angus crosses, and bring prices as good as most beef cattle. A pair of yearling heifers brought $62 each, while the average price of a dozen or more hand-reared, two-year-old fat steers is about $92.50. There was little or no discrimination against them on account of the Jersey blood they carried.

The two F_3 calves were born since I saw the herd but according to information received from the estate they are very dark. Six more F_3 calves are expected this winter, and the heifers of this cross will be mated with an F_3 bull.

It is the owner's intention to continue this work and perhaps establish a new breed. Of course this will necessarily require a long time and the discarding of many animals that do not come up to the standard.

This herd was particularly interesting to me for the same cross was begun by Leon J. Cole of the Department of Experimental Breeding of the University of Wisconsin in 1912, but without knowledge at the time of this practical trial which was started several years earlier. In the Wisconsin experiment Jersey cows are mated with an Angus bull and Angus cows with a Jersey bull. The object is to study the segregation and behavior of the characters of these two breeds, which differ so markedly in conformation, type and function. Thus far only the first cross, consisting of seven F_1 offspring, has been obtained and as might be expected they are similar to those obtained from the same cross in England. By means of measurements and analyses it is hoped to secure information on the number, nature and method of transmission of many of the characters of the two breeds.

Genealogy and Eugenics

An International Congress of Genealogy will assemble at San Francisco during the week beginning Monday, July 26, under the management of the California Genealogical Society. All genealogical, historical, patriotic and family societies and associations throughout the world are invited to appoint delegates. Among the subjects for consideration is the relation between genealogical investigation and eugenics. Miss Carlie Inez Tomlinson, Exposition Building, San Francisco, is secretary of the committee on organization.

TOBACCO MUTATIONS

Sports of Great Value Apparently Not Due to Hybridization But to Some Change in the Reproductive Cells After Fertilization—History of the Mutants.[1]

H. K. Hayes

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SOME one has said that inheritance is the ability to produce certain characters under certain favorable conditions of environment. As some plants have slightly more favorable conditions than others, even when all are grown under fairly uniform environment, we find that there are always some plants in which the character under observation is more fully developed than in others. Permanent improvement in plants by the selection of these fluctuations has not, however, generally been obtained, and when this method has given new types the results can, as a rule, be more logically explained as due to the isolation of the better biotypes of the race than by the gradual production of a new character by continuous selection. The ability of a breeder to produce new types is therefore dependent on the possibility of obtaining new inheritable variations.

We now know that variation can be produced by crossing. If we cross two biotypes which differ by certain characters, an increase in variability is obtained in the second generation after the cross. The selection in this generation of those plants which most nearly approach the desired habit, and further pedigreed breeding until the races breed true for the desired characters, have produced many new plant varieties of economic importance.

New types in supposedly homozygous material, which suddenly appear and cannot be explained by crossing, are known as mutations. It is the purpose of this paper to describe a constantly recurring mutation in Connecticut Havana tobacco and to give further notes in regard to the sport which appeared in 1912 in a field of Connecticut Cuban shade tobacco.

SHADE TOBACCO IN CONNECTICUT.

The history of the production of the Connecticut Cuban shade type is well known. It was first grown in this country in 1904 from seed which was brought from Cuba the previous year by William Hazelwood, of New York City. The first few crops were variable in habit, but selection soon served to isolate numerous biotypes. One line known as 13-29 proved its superiority. Seed from a number of self-fertilized plants of this line was saved in 1908 and was used for planting in 1910 at the Windsor Tobacco Growers' Corporation in Bloomfield, giving a crop of uniform appearance in which no variations of importance were noticed. A large number of seed plants of this crop were saved, although the individual seedheads were not separately covered with a manila paper bag to prevent crossing, as was the plan from 1904 to 1909. It does not seem very likely, however, that much crossing would take place under the cheesecloth cover, and even if some crossing took place it would be between homozygous individuals. Thus, prior to 1910 the Cuban variety was selfed for six generations and gave every evidence that it was of a homozygous nature.

Further evidence that this Cuban strain was homozygous for leaf number may be given by the following experiment. In 1910, 150 plants grown from

[1] This Study was made at the Connecticut Experiment Station in New Haven.

THE MUTANT AND ITS PARENT

At the left, a "Stewart Cuban" plant, at the right a plant of the normal Cuban tobacco from which the former originated suddenly in 1909. Photograph taken August 1, 1913: the normal type has already produced a blossom, while the mutant flowers very much later. The greater leaf yield of the mutant will also be noticed. (Fig. 12.)

the 1908 Cuban seed were carefully counted for leaf number, the method being to count the leaves on the main stem beginning at the fourth leaf from the base and counting to the leaf below the bald sucker at the top, the bald sucker being the first sucker which does not produce true leaves. This method gives approximately the number of leaves which are usually harvested. In 1910 the plant which had the largest leaf number was self-pollinated by covering the seed-head with a manila paper bag. This method of selection for high leaf number has been continued from 1910 to 1914, inclusive, each year a plant with high leaf number being selected as a parent for the following generation. The total variation for leaf number was from 14 to 25 leaves per plant. The mean for 1910 was 19.9 leaves per plant, and in 1914 a mean of 19.9 leaves was also obtained. A total of 832 plants was counted, the smallest number of plants grown in any generation being 124 and the largest number 210. The experiment has therefore given negative results and serves to illustrate the impossibility in this variety of increasing the average leaf number by the continuous selection of fluctuations.

NEW TYPE INCREASED.

In 1912 the Windsor Tobacco Growers' Corporation grew about 100 acres of shade tobacco from seed saved under the cheesecloth cover in 1910. The general appearance of the crop was uniform, and until late in the season no variations of importance were noted. During the clearing of the field by cutting down the stalks, one plant after being cut was observed to have a large number of unpicked leaves and no blossom. This plant was brought to the attention of the plantation manager, J. B. Stewart, who, after systematic search, found two others of similar habit. One of these, on being transplanted and taken to the greenhouse of the Connecticut Agricultural Experiment Station in New Haven, survived and bore 72 leaves on the main stem, blossoming about January first. Considerable seed was saved from this plant.

In 1913 about one-third of an acre of this new type was grown at the Windsor Tobacco Corporation's plantation. The plants were of uniform appearance and differed from the normal Cuban in having leaves of a somewhat lighter green shade, in a partial absence of basal suckers, and in a practically indeterminate growth, whereas the normal Cuban variety bears a terminal inflorescence after producing from 14 to 25 leaves on the main stem. Twenty plants were taken to the Connecticut Experiment Station greenhouse in the fall of 1913. These commenced to blossom about the first of November, the range of leaf counts being from 62 to 80 leaves per plant.

About 25 acres of the new type, which has been called the "Stewart Cuban," have been grown in the valley this last season, and all bred true to the new habit of growth.

The third of an acre of Stewart Cuban which was grown at the Windsor Tobacco Corporation's plantation in 1913 was fermented, assorted, and compared with the Hazelwood Cuban type. The quality of leaf seemed as good as that of the normal type, and an increased yield per acre of approximately 90% was obtained. The value of the 1914 crop will also be determined. As the final determination of the value of a new type of tobacco depends on its conformity to the trade ideals, it is too soon to make any definite statements about the value of this new type.

In order to obtain seed of the Stewart Cuban it is necessary to transplant a few plants to the greenhouse and thus prolong their period of growth. Plants thus transplanted blossomed about November first, producing an average of 70 leaves on the main stem. As the tobacco seed-beds are generally started about the first of April, it was thought that sowing seed in the greenhouse the last of December and growing the plants in pots until the last of May and then transplanting them out of doors would give them sufficient start so that they would blossom before frost in the Fall. Accordingly, on December 28, 1913, some seed of the Stewart Cuban was sown in sterilized

AFTER THE SECOND PICKING

Stewart Cuban shade grown tobacco at Windsor, Conn., August 18, 1913. These plants have produced more than 30 leaves to the stalk, and two pickings have already been made. As the lower leaves ripen sooner than the upper ones do, they are harvested first, and five or six pickings are required to get the entire crop at the right stage. (Fig. 13.)

soil in the greenhouse of the Connecticut Agricultural Experiment Station, the plants being transplanted when necessary, 8-inch pots bei g finally used. About the last of May, the plants were set out in the garden at the Connecticut Agricultural Station grounds in New Haven. They grew luxuriantly during the season, and about the middle of September they were photographed and examined. At this time they were from 12 to 14 feet tall, had produced an average of 80 leaves to the plant, and none showed signs of a blossom. On transplanting these to the greenhouse, however, only a few more leaves were

produced and all plants blossomed early in October. It seems very likely that a change in conditions may cause the plants to blossom.

OTHER MUTANTS FOUND.

The normal Cuban seed which was saved in 1910 was again used for planting in 1913 and 1914, and over 350 acres, or two and a half million plants, were grown. Although search was made at the Windsor Tobacco Growers' Corporation, which grows over 200 acres, no mutating plants were found. Several plants were, however, reported from other plantations where the 1910 Windsor Tobacco Corporation seed was used, which presented the same habit of producing a large leaf number. As all plants of this new type came from the same seed, it can not be stated that they did not come from a single normal plant.

Mutations of high leaf number have been observed in tobacco previous to this time. Several years ago a variant with a large leaf number was found in the outdoor Havana type at the farm of Mr. Alsop in Avon, and in 1912 two Havana plants which bore a large number of leaves were found at the Olds Brothers' plantation in Bloomfield. One other similar plant was found by another Bloomfield farmer.

The Olds Brothers' Havana sport found in 1912 has now been tested, about five hundred plants of this type being grown in 1914. All bred true and none showed signs of a blossom during the normal growing season.

It is of interest that these mutations have occurred in a variety, the Connecticut Havana, which has been grown in Connecticut for a period of over 50 years and which is of uniform habit. That it has been observed in different sections and by different growers shows that the same mutation must have taken place several times. In all of the above examples the mutation has only appeared for a single generation.

Recently, however, we have learned of a constantly recurring mutation for large leaf number which has been observed and studied by L. A. Clapp, a tobacco farmer of Windsor. Mr. Clapp grew 24 acres of Connecticut Havana in 1912 from seed which he saved in 1911 from normal Havana plants. The Havana, as is the case with Cuban, produces from 14 to 25 leaves on the main stem before blossoming. During the work of harvesting his crop by the priming method,[2] Mr. Clapp observed six plants which had not produced a blossom and which bore a large number of unpicked leaves. Thirty-six leaves from one of these plants were harvested, strung on a single lath and, after being cured, were examined by a tobacco buyer, who was very much pleased with their quality.

This interested Mr. Clapp, who examined his 24 acre field in 1913, which he grew from seed saved from normal plants of his 1912 crop. After careful search, a dozen plants of the many-leaved type were found. One of these was transplanted and taken to a greenhouse. It blossomed during the winter and some seed was obtained. Mr. Clapp grew about 500 plants of this type in 1914 and all bred true to the new habit.

24 acres of the normal Havana were grown in 1914 from seed saved from normal 1913 plants and, while no careful counts were made, Mr. Clapp observed about 50 plants of the many-leaved type.

These mutations can hardly be explained as the result of accidental crosses. A large series of crosses have been made in Connecticut, and, as a rule, there has been some increase of variability for leaf number in the second hybrid generation. In no case have we obtained types which exhibit this pe-

[2] The "priming method" of harvesting a tobacco crop is a recognition of the fact that the lower leaves of a plant ripen before the upper leaves. In it, four or five pickings are usually made: at the first one three or four leaves are taken, at the second five to seven, the same number at the third picking, and all remaining leaves at the fourth picking, when only four are made. The method was introduced into Connecticut with the culture of tobacco under cheesecloth cover, and the entire crop (over 2,000 acres) of tobacco grown under cover in the Connecticut valley is harvested by priming; most of the tobacco grown outdoors is still harvested by the old method of cutting the entire plant close to the ground.

culiarity of a practically indeterminate growth.

DeVries recognized two types of mutation: (1), a germinal change in either the male or female reproductive cell before fertilization, in which case the mutating individual was a first generation hybrid and did not breed true; and (2), a mutation after the union of the male and female reproductive cells. He chiefly emphasized mutations belonging to this second class as they bred true and could therefore be distinguished from variations due to hybridization. These tobacco mutations seem to belong to the class in which a change has taken place after fertilization. DeVries also believed in periods of mutation. From this standpoint the constantly recurring variation in the Connecticut Havana variety is of some interest.

NEW PUBLICATIONS

EINFÜHRUNG IN DIE EXPERIMENTELLE VEREBUNGSLEHRE, von Prof. Dr. phil. et med. Erwin Baur. 2. neubearbeitete Auflage mit 131 Textfiguren und 10 farbigen Tafeln. Verlag von Gebrüder Borntraeger, Berlin W. 35, 1914. Pp. 401, 14 mk., 50 pfg.

Dr. Baur's Introduction to Genetics, which was published in 1911, has been reissued after complete revision which brings it up to date. It covers much the same ground as the text-books of Plate and Goldschmidt; one must regret that no English geneticist has yet produced a text-book on similar lines. Although intended primarily for students, Baur's work will be of interest to every geneticist, because of the extent to which he has drawn on his own researches for illustrative material. The book, as its title promises, confines itself as nearly as possible to experimental data, admitting only as much theoretical discussion as seems absolutely necessary; the cytological section has also been reduced to a minimum. The illustrations are particularly good. A bibliography of 30 pages will be welcomed by many.

THE FUNDAMENTALS OF PLANT BREEDING, by John M. Coulter. Pp. xiv+346, 109 figures, price $1.50. New York and Chicago, D. Appleton and Company, 1914.

Dr. Coulter, head of the department of botany of the University of Chicago, has written this book for "those who wish a simple statement of evolution and heredity; who wish information concerning the revolution in plant breeding; or who wish a general introduction to the fundamental principles underlying agriculture. This should include citizens interested in the things that make for the public welfare, farmers, students of agriculture, teachers in the public schools, and botanists." People belonging to these classes will find it useful and satisfactory; it tells the story of the application of genetics to horticulture and agriculture in a comprehensive, although necessarily general way, and does so understandably. These qualities are certain to secure it a wide welcome. The typography and illustrations, however, are not worthy of the book.

Restrictions of Marriage

There may be some who think the English would be happier if their marriages were arranged at Westminster, instead of, as hitherto, in Heaven. I am not of that opinion, nor can I suppose that the constructive proposals even of the less-advanced eugenists would be seriously supported by any one who realized how slender is our present knowledge of the details of the genetic processes in their application to man. Before science can claim to have any positive guidance to offer, numbers of untouched problems must be solved. As regards practical interference there is nevertheless one perfectly clear line of action which we may be agreed to take—the segregation of the hopelessly unfit.—William Bateson. Biological Fact and the Structure of Society (1912).

THE PEOPLING OF AMERICA

Aborigines Represent the Yellow-brown Race of Asia and Polynesia—Arrived on This Continent in Relatively Recent Period—Characteristics of the Stock.[1]

DR. ALES HRDLICKA,
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FOR the American anthropologist no subject is of more interest than that of the racial affinity and the place or places of origin of the American aborigines. Ever since the discovery of the new continent and its peoples these questions have occupied many minds, but have not as yet been brought to the point of final answer. Numerous opinions were advanced, but they were almost wholly the results of speculation, fettered on one side by lack of scientific research and on the other by various traditions.

When Columbus discovered the New World he and his companions imagined, as is well known, that they had reached the Indies, and the people met were naturally taken for natives of those regions. Later, as the true nature of the new land became better known, speculation concerning the newly discovered race took other directions, and some of the notions developed proved disastrous to the Indians. History tells us that many of the early Spaniards, up to Las Casas' time, reached the conclusion that, as no mention was made concerning the American people in Hebrew traditions, they could not strictly be regarded as men equivalent to those named in biblical accounts, and this view, before being counteracted, led directly or indirectly to much enslavement and destruction of the native Americans.

Later, the origin of the Indians was sought in other parts of the world, and the seeming necessity of harmonizing this origin with biblical knowledge led to many curious opinions.[2] One of these, held by Gomara, Lerius, and Lescarbot, was to the effect that the American aborigines were the descendants of the Canaanites who were expelled from their original abode by Joshua; another, held especially by McIntosh,[3] that they were descended from Asiatics who themselves originated from Magog, the second son of Japhet; but the most widespread theory, and one, the remnant of which we meet to this day, was that the American Indians represented the so-called Lost Tribes of Israel.[4]

MORE RATIONAL IDEAS.

During the course of the nineteenth century, with Levegue, Humboldt,[5] McCullogh,[6] Morton,[7] and especially Quatrefages,[8] we begin to encounter more rational hypotheses concerning the Indians, although by no means a single opinion. Lord Kaimes, Morton,

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[1] Extract from the proceedings of the Eighteenth International Congress of Americanists. The photographs of Asiatic types were furnished by Dr. Hrdlicka, the photographs of American types by the Smithsonian Institution, Bureau of American Ethnology.

[2] See Garcia Clavigero and the older American historians.

[3] McIntosh, J., "Origin of the North American Indians," New York, 1843.

[4] Adair, J., "History of the North American Indians," London, 1775.

[5] Humboldt, "Political Essay," I, p. 115; Humboldt and Bonpland, "Voyage, Vues des Cordillères," Paris, 1810.

[6] McCullogh, "Researches, Philosophical and Antiquarian, Concerning the Aboriginal History of America," Baltimore, 1829.

[7] Morton, S. G., "Distinctive Characteristics of the Aboriginal Race of America," 2nd ed., pp. 35-36, Philadelphia, 1844. (Also his "Crania Americana" and "Origin of the Human Species.")

[8] Quatrefages, "Histoire générale des races humaines," Paris, 1887.

MONGOLIAN WOMAN AT URGA

If dressed in the clothes of the American Indian she could not be distinguished from a native of the New World, according to Dr. Hrdlicka. Urga is the capital of Outer Mongolia. (Fig. 14.)

PAWNEE GIRL FROM CENTRAL UNITED STATES

The slight upward slant of the eye-slit, and the characteristic conformation of the upper lid at the inner corner of the eye, both usually supposed to be characteristic of the Mongolians, are in reality equally common among the American Indians. The "white of the eye" is yellowish, again as in the Mongolian race. (Fig. 15.)

and Nott and Gliddon[9] professed the belief that the American natives originated in the new world and hence were truly autochthonous; Grotius believed that Yucatan had been peopled by early Christian Ethiopians; according to Mitchell the ancestors of the Indians came to this country partly from the Pacific Ocean and partly from north-eastern Asia; the erudite Dr. McCullogh believed that the Indians originated from parts of different peoples who reached America over lost land from the west "when the surface of the earth allowed a free transit for quadrupeds." Quatrefages viewed the Americans as a conglomerate people, resulting from the fossil race of Lagoa Santa, the race of Parana, and probably others, in addition to which he believed there had been settlements of Polynesians; and Pickering thought that the Indians originated partly from the Mongolian and partly from the Malay.

The majority of the authors of the last century, however, including Humboldt, Brerewood, Bell, Swinton, Jefferson, Latham, Quatrefages, and Peschel,[10] inclined to the belief that all the American natives, excepting the Eskimo, were of one and the same race and that they were the descendants of immigrants from North-eastern Asia, particularly of the "Tartars" or Mongolians.

The most recent writers, with one marked exception, agree entirely that this country was peopled through immigration and local multiplication of people; but the locality, nature, and time of the immigration are still much mooted questions. Some authors incline to the exclusively north-eastern Asiatic origin; others, such as Ten Kate and Rivet, show a tendency to follow Quatrefages in attributing at least some parts of the native American population to the Polynesians; Brinton[11] held that they came in ancient times over a land connection from Europe; and Kollmann,[12] basing his belief on some small crania, believes that a dwarf race preceded the Indian in America.

AMEGHINO'S HYPOTHESIS.

A remarkable hypothesis concerning the origin of the American native population, deserving a few words apart, has within the last 30 years, and especially since the beginning of this century, been built up by Ameghino,[13] the South American paleontologist. This hypothesis is, in brief, that man—not merely the American race, but mankind—originated in South America; that the early man became differentiated in the southern continent into a number of species, most of which eventually became extinct; that from South America his ancestors migrated over ancient land connections to Africa, and from there peopled, in the form of *Homo ater*, the larger parts of the African continent and Oceania; that a strain multiplied and spread over South America, and somewhere in the second half of the Pliocene migrated to North America and that from North America man went to Asia and Europe, where he gave rise to the *Homo mongolicus* and *Homo caucasicus*.

In addition there have been some suggestions that the Americans may have arrived from the "lost Atlantis;" and the theory has even been expressed that man, instead of migrating from north-eastern Asia into America, may have moved in the opposite direction, and especially that, after peopling this continent, a part of the Americans reached Siberia.[14]

[9] Nott and Gliddon, "Types of Mankind, and Indigenous Races." (The latter includes statements by Leidy and Morton.)

[10] Peschel, O., "The Races of Man," p. 418, 1876.

[11] Brinton, D. G., "The American Race," New York, 1891.

[12] Kollmann, J., "Die Pygmäen" (Verh. d. Naturforsch, Ges. Basel, xvi, Basel, 1902).

[13] Ameghino, F., "El Tetraprothomo Argentinus" (Anal. Mus. Nac. xvi, Buenos Aires, 1907); also "Le Diprothomo platensis" (ibid., xix, 1909).

[14] In this connection see also Campbell, J., "Asiatic Tribes in North America," Proc. Canadian Inst., N. S., i, Toronto, 1881; Mason, O. T., "Migration and the Food Quest; a Study in the Peopling of America," Smithsonian Report for 1894, Washington, 1896, pp. 523-540; Morse, E. S., "Was Middle America Peopled from Asia?" Popular Sci. Mo., November, 1898; Powell, J. W., "Whence Came the American Indians?" Forum, February, 1898; "Major Powell's Inquiry, 'Whence Came the American Indian?' An Answer," by J. Wickersham, Tacoma, Washington

GILIAK WOMAN FROM ISLAND OF SAKHALIN

Many of the women of this part of Asia, "individually less modified by environment than the men, if introduced among the Indians and dressed to correspond, could by no means at the disposal of the anthropologist be distinguished apart," says Dr. Hrdlicka. (Fig. 16.)

YAKIMA INDIAN, SHAHAPTIAN STOCK

The habitat of this tribe is in the extreme northwest United States and British Columbia. The broad face, well developed chin and large mouth with slightly full lips are highly characteristic of the yellow-brown race, whether it be studied in Asia or America. (Fig. 17.)

The Eskimo have been generally considered as apart from the Indian, some holding that they preceded and others that they followed him. They have been connected generally with the north-eastern Asiatics, but there are also those who see a close original relation between the Eskimo and the Lapps, and even between the Eskimo and the Paleolithic Europeans.

These are, in brief, the various more or less speculative opinions that so far have been advanced in an effort to explain the ethnic identity and the place of origin of the American Indian; and it is only logical that the next word on these problems be given to physical anthropology, which deals with what are, on the whole, the least mutable parts of man, namely, his body and skeleton.

The somatology of the Indians, which barely saw its beginnings in the time of Humboldt and Morton, has now advanced to such a degree that at least some important generalizations concerning the American aborigines are possible. We have now at our disposal for comparison, in American museums alone, upwards of 20,000 Indian crania and skeletons from all parts of the continent, while several thousand similar specimens are contained in European collections. A considerable advance, particularly in North America, has also been made in studying the living natives. Unfortunately, we are much less advantageously situated in regard to comparative skeletal material as well as with respect to data on the living man from other parts of the world, particularly from those regions where other indications lead us to look for the origin of the Indian.

THE FACTS IN THE CASE.

What can be stated in the light of present knowledge concerning the American native with a fair degree of positiveness is that:

1. There is no acceptable evidence, nor any probability, that man originated on this continent;

2. Man did not reach America until after attaining a development superior to that of late Pleistocene man in Europe, and after having undergone advanced and thorough stem, and even racial and tribal, differentiation; and

3. While man, since the peopling of the American continent was commenced, has developed numerous secondary, sub-racial, localized structural modifications, these modifications cannot yet be regarded as fixed, and in no important features have they obliterated the old type and sub-types of the people.

We are further in a position to state that, notwithstanding the various secondary physical modifications referred to, the American natives, barring the more distantly related Eskimo, present throughout the Western Hemisphere numerous important features in common, which mark them plainly as parts of one stem of humanity. These features are:[15]

1. The color of the skin. The color of the Indian differs, according to localities, from dusky yellowish-white to that of solid chocolate, but the prevailing color is brown.

2. The hair of the Indian, as a rule, is black, medium coarse and straight; the beard is scanty, especially on the sides of the face, and it is never long. There is no hair on the body except in the axillae and on the pubis, and even there it is usually sparse.

3. The Indian is generally free from characteristic odor. His heart-beat is slow. His mental characteristics are everywhere much alike. The size of the head and of the brain cavity is comparable throughout, averaging somewhat less than that of white men and women of similar stature.

4. The eyes, as a rule, are dark brown in color, with dirty yellowish conjunctiva in adults, and the eye-slits show a prevailing tendency, more or less

1899, pp. 1-28; Hallock, Charles, "The Ancestors of the American Indigenes," Amer. Antiquarian, xxiv, No. 1, 1902, and the publications of the Jesup Expedition of the American Museum of Natural History, New York.

[15] The remarks apply to the Indian not affected by sedentary habits and other conditions due to changed mode of life attending the process of civilization.

A YOUNG MANCHU

He would pass without the slightest difficulty for an Indian student at Haskell or Carlisle, Dr. Hrdlicka remarks. The nose is characteristic of the stock on both sides of the Pacific, being mesorhinic or moderately broad—not flat like that of a negro nor again thin like that of a Caucasian. (Fig. 18.)

PIMA INDIAN FROM ARIZONA

With the headdress peculiar to some of his tribe, he would easily pass for an oriental. As Dr. Hrdlicka notes, the American Indian resembles the Polynesian quite as strongly as he often does the "Tartar" or Mongolian. In many of the Mexican tribes the resemblance is still more striking. (Fig. 19.)

noticeable in different tribes, to a slight upward slant, that is, the external canthi are frequently more or less higher than the internal.

5. The nasal bridge is moderately to well developed, and the nose in the living, as well as the nasal aperture in the skull (barring individual and some localized exceptions), show medium or mesorhinic relative proportions. The malar regions are, as a rule, rather large or prominent.

TEETH ARE CHARACTERISTIC.

6. The mouth is generally fairly large, the lips average from medium to slightly fuller than in whites, and the lower facial region shows throughout a medium degree of prognathism, standing, like the relative proportions of the nose, about midway between those in the whites and those characteristic of the negroes. The chin is well developed, not seldom square. The teeth are of medium size when compared with those of primitive man in general, but perceptibly larger when contrasted with those of the cultured white American or European; the upper incisors of the Indian present an especially important feature; they are characteristically shovel-shaped, that is, deeply and peculiarly concave on the buccal side. The ears are rather large.

7. The neck, as a rule, is of only moderate length, and in health is never thin; the chest is somewhat deeper than in average whites; the breasts of the women are of medium size, and generally more or less conical in form. There is a complete absence of steatopygy; the lower limbs are less shapely and especially less full than in whites; the calf in the majority is small.

8. The hands and feet, as a rule, are of relatively moderate or even of small dimensions, and what is among the most important features distinguishing the Indian, the relative proportions of his forearms to arms and those of the distal parts of the lower limbs to the proximal (or, in the skeleton, the radio-humeral and tibio-femoral indices) are in general, throughout the two parts of the continent, of much the same average value, which value differs from that of both the whites and the negroes, standing again in an intermediary position.

This list of characteristics, which are, broadly speaking, shared by all American natives, could readily be extended, but the common features mentioned ought to be sufficient to make clear the fundamental unity of the Indians.

The question that necessarily follows is: "Which, among the different peoples of the globe, does the Indian as here characterized most resemble?" The answer, notwithstanding our imperfect knowledge, can be given quite conclusively. There is a great stem of humanity which embraces people ranging from yellowish-white to dark brown in color, with straight black hair, scanty beard, hairless body, brown, often more or less slanting eye, prevalently mesorhinic nose, medium alveolar prognathism, and in many other essential features much like the American native; and this stem, embracing several sub-types and many nationalities and tribes, occupies the eastern half of the Asiatic continent and a large part of Polynesia.

CLOSE RELATIONSHIP.

From the physical anthropologist's point of view everything indicates that the origin of the American Indian is to be sought among the yellowish-brown peoples mentioned. There are no two large branches of humanity on the globe that show closer fundamental physical relations.

But difficulties arise when we endeavor to assign the origin of the Indian to some particular branch of the yellowish-brown population. We find that he stands quite as closely related to some of the Malaysian peoples as to a part of the Tibetans, or some of the north-eastern Asiatics. It is doubtless this fact that accounts for the hypotheses that attribute the derivation of the American Indians partly to the "Tartars" and partly to the Polynesians.

All that may be said on this occasion is that the circumstances point strongly to a coming, not strictly a migration, after the glacial period, and over land, ice, water, or by all these media combined, from north-eastern Asia, of

PROFILE OF YOUNG MANCHU

The same individual was shown full face in fig. 18. Compare his alveolar prognathism with that of the American Indian in the next cut. The ear, it will be noted, is rather large,—a racial characteristic of the Indian, also. The hair, coarse, black, and straight, is precisely like that of the American Indian. (Fig. 20.)

A PUGET SOUND INDIAN

Skit-wish tribe, Salisham stock. He illustrates the characteristic alveolar prognathism of the Indian—the slight projection of the teeth, altering the profile. The white race rarely shows this projection in such a degree, while in the negro race it is still more pronounced. (Fig. 21.)

relatively small parties, overflows of the far eastern populations of that time, and to the peopling of America by the local multiplication of man thus introduced, to comings repeated probably nearly to the beginning of the historic period.

As to Polynesian migrations within the Pacific, such were, so far as can be determined, all relatively recent, having taken place when America doubtless had already a large population and had developed several native cultures. It is, however, probable that after spreading over the islands, small parties of Polynesians have accidentally reached America. If so, they may have modified in some respects the native culture; but physically, being radically like the people who received them (barring their probably more recent negro mixture), they would readily blend with the Indian and their progeny could not be distinguished. In a similar way small parties of whites may have probably reached the continent in the east. They, too, may have introduced some cultural modifications, but they would necessarily consist of men only and of parties small in number, which would in the course of time blend thoroughly with the Indian.

The conclusions, therefore, are: the American natives represent in the main a single stem or strain of people, one homotype; this stem is identical with that of the yellow-brown races of Asia and Polynesia; and the main immigration of the Americans has taken place, in the main, at least, gradually and by the northwestern route in the earlier part of the recent period, after man had reached a relatively high stage of physical development and multiple secondary differentiations. The immigration, in all probability, was a dribbling and prolonged overflow, likely due to pressure from behind, or want, and a search for better hunting and fishing grounds in the direction where no resistance of man as yet existed. This was followed by multiplication, spread, and numerous minor differentiations of the people on the new, vast, and environmentally highly varied continent, by rapid differentiation of language due to isolation and other natural conditions, and by the development, on the basis of what was transported, of more or less localized American cultures. It is also probable that the western coast of America, within the last 2,000 years, was on more than one occasion reached by small parties of Polynesians, and that the eastern coast was similarly reached by small groups of whites, and that such parties may have locally influenced the culture of the Americans; but such accretions have nowhere, as far as we know today, modified the native population.

Genetics and Government

The great danger of democracy is that, more even than other forms of government, it may consider reforms too exclusively from the point of view of the immediate comfort of the individual, and may ignore the slow but irrevocable effect on the inborn character of future generations. All the more necessary is it that those who venture to assume the heavy responsibility of attempting to legislate for democracy should understand the nature of the fundamental problems of race on which the future welfare of the nation depends. The time may come when a genealogical survey of the families of a nation will be recognized to be of greater value than a geological survey of the country they occupy.—W. C. D. and C. D. Whetham: Heredity and Society.

Breeding for Energy

In any scheme of eugenics, energy is the most important quality to favor; it is, as we have seen, the basis of living action, and it is eminently transmissible by descent.—Francis Galton: Inquiries into Human Faculty (1907).

THE EARLY MARRIAGE QUESTION

"IT IS important," Galton remarked in 1883, "to obtain a just idea of the relative effects of early and late marriages." He attempted to do this in several ways, one of the most striking of which was that published in his "Inquiries into Human Faculty," and based on Duncan's statistics from a maternity hospital. Dividing the mothers into five-year groups, according to their age, and stating the medium age of the group, for the sake of simplicity, instead of giving the limits, he arrived at the following table:

Age of Mother at Her Marriage	Approximate Average Fertility
17	9.00—6 x 1.5
22	7.50—5 x 1.5
27	6.00—4 x 1.5
32	4.50—3 x 1.5

"which shows that the relative fertility of mothers married at the ages of 17, 22, 27 and 32 respectively is as 6, 5, 4 and 3 approximately.

"The increase in population by a habit of early marriages," he adds, "is further augmented by the greater rapidity with which the generations follow each other. By the joint effect of these two causes, a large effect is in time produced."

R. H. Johnson considered this phase of the question graphically in the JOURNAL OF HEREDITY for March, 1914. He said: "Suppose a generation to be 25 years or 33⅓ years respectively in two different stocks, and that all persons marry and each couple have four surviving children, or two for each parent. The result is that the 25-year stock constitutes two-thirds of the population at the end of a century."

By a combination of these two causes (to which might be added the lower death-rate claimed among the children of young parents), the result is, as Galton says, that "if the races best fitted to occupy the land are encouraged to marry early, they will breed down the others in a very few generations."

Something similar has happened in New England and many other regions, where a fertile foreign stock, marrying early, has nearly supplanted the earlier stock. The fact has frequently been a text for eugenic sermons.

But other eugenists have flatly denied the desirability of this sort of selective breeding, as applied to the human race. They have alleged that early childbearing had a bad physical effect on the mother, and both a bad physical and a bad mental effect on the offspring. The latter charge was made in an emphatic form by Casper L. Redfield of Chicago, as an answer[1] to Professor Johnson's article above cited. After quoting Johnson's illustration, he wrote:

ADVANTAGES CHALLENGED.

"The object of reproducing at the rate of four generations to the century is, of course, to produce superior individuals and increase the relative number of them in the entire population. Well, I will donate $100 to the treasury of the American Genetic Association if it can be shown that any superior individual was ever produced by breeding human beings as rapidly as four generations to the century. It is only necessary to find some superior individual from the intellectual standpoint whose date of birth is not more than 100 years after the average date of birth of his 16 great-great-grandparents. Any one of the 2000 or 3000 intellectually eminent men known to history, who comes in the four-generations-to-a-century class, will draw the $100.

"To make the matter interesting and easy, I will be satisfied to give the $100 if there can be found more than three

[1] Results of Early Marriage, by Casper L. Redfield. JOURNAL OF HEREDITY, V, 7, p. 316, July, 1914. Mr. Redfield's general position on the question of early marriage is set forth fully in his book "The Control of Heredity" (1903), and summarily in his more recent work "Dynamic Evolution" (New York and London, G. P. Putnam's Sons, 1914).

cases in which the intellectually superior person has as many as four generations in a century in the tail-male line alone."

Mr. Redfield then notes that much more than one-half of all people come within a three-generations-to-the-century class, taking the average age of male ancestors only, and continues:

"Now raising the standard of superior individuals to the exceptionally great men such as Aristotle, Augustus, Newton, Bacon, Faraday, Franklin, Humboldt, Cuvier, Darwin, etc., of whom there are some two or three hundred known to history, I will give a second $100 to the treasury of the American Genetic Association if a single one of them can be found in this three-generations-to-a-century class."

The time limit on both these offers was set at December 31, 1914. They were widely copied by newspapers throughout the United States, and a number of pedigrees sent in, but none of them conformed to the requirements. The most interesting letter in connection with the offer was sent directly to Mr. Redfield by J. B. Nicklin, Jr., of 516 Poplar street, Chattanooga, Tenn., who wrote:

"In reply to your offer in the *Hartford Times* I beg to submit the proven instances of five and six generations in less than a century:

1. Edward, Duke of Kent, born 1784.
2. Queen Victoria, born 1819.
3. Victoria, Empress of Germany, born 1840.
4. Wilhelm II, Emperor of Germany, born 1859.
5. Friedrich Wilhelm, Crown Prince, born 1882, making five generations in 98 years.

1. Maria Theresa, born 1717.
2. Leopold II, Emperor of Austria, born 1747.
3. Francis I, Emperor of Austria, born 1768.
4. Marie Louise, Empress of the French, born 1791.
5. Napoleon II, born 1811, making five generations in 94 years.

1. Josephine, Empress of the French, born 1763.
2. Eugene de Beauharnais, born 1781.
3. Josephine, Queen of Sweden, born 1807.
4. Carl XV, King of Sweden, born 1826.
5. Louise, Queen of Denmark, born 1851, making five generations in 88 years. Also four in 63 years.

1. Martha (Dandridge) Custis Washington, born 1732.
2. John Parke Custis, born 1755.
3. George Washington Parke Custis, born 1781.
4. Mary Anne Randolph (Custis) Lee, born 1807.
5. George Washington Custis Lee, born 1832 (son of Robert E. Lee), making five generations in exactly 100 years.

1. John Bailey Nicklin, born 1803.
2. Elizabeth Catharine (Nicklin) Connoly, born 1833.
3. Laura Nicklin (Connoly) Lee, born 1853.
4. Laura Florence (Lee) Dennison, born 1877.
5. Robert Lee Dennison, born 1901, making five generations in 98 years and in my own family.

1. Queen Victoria, born 1819.
2. Victoria, Empress of Germany, born 1840.
3. Wilhelm II, Emperor of Germany, born 1859.
4. Friedrich Wilhelm, Crown Prince of Germany, born 1882.
5. Eitel, his eldest son, born 1906, making five generations in 87 years.

1. Mary (Gregory) Taylor, born 1666.
2. Mary Bishop (Taylor) Pendelton, born 1688 (aunt of the President).
3. Philip Pendelton, born 1704 (her *second* son).
4. Mary (Pendelton) Waller, born 1722.
5. William Edmund Waller, born 1741.
6. Benjamin Waller, born 1762, making six generations in 96 years and proven by the Court Records in Virginia.

"I believe that these records, and I can send countless others should you desire them, will prove to you the fact that a century can and has produced four, five and six generations."

In reply to this letter Mr. Redfield wrote to Mr. Nicklin as follows:

"I have received your letter of December 10 and have forwarded it to the American Genetic Association, 511 Eleventh St., N. W., Washington, D. C. The money of my offer was deposited with the association some months since, and all decisions in the matter rest with them.

"I have not seen the notice in the *Hartford Times* and have not before heard of it. Consequently I do not know what the notice may contain, but I enclose a copy of my offer so that you may see exactly what it is.

"The persons you mention are

1. Friedrich Wilhelm, Crown Prince of Germany.
2. Napoleon II of France.
3. Louise, Queen of Denmark.
4. G. W. C. Lee, president of Washington and Lee University.
5. R. L. Dennison, born 1901.
6. Eitel, son of German Crown Prince.
7. W. L. E. Waller, born 1741.
8. Benjamin Waller, born 1762.

"The objections are:

"First, the persons named are not among 'the 2000 or 3000 intellectually eminent men known to history,' whose names are recorded in ordinary encylopedias because of intellectual achievements. Not all royal personages noted in cyclopedias are there because of their intellectual superiority.

"Second, the pedigrees given are neither complete pedigrees, nor in the tail-male line for partial pedigrees.

"The generations of the offer are periods of time between parent and offspring. Except in the last case, you give four such periods, and consequently four generations instead of five as you represent it.

"Examples of breeding much more rapid than those you give are quite common, as among the 'Jukes' and other degenerate families of the United States; also in Asia, Africa and Polynesia. Marriages between boys less than 17 and girls less than 15 are the ordinary thing in many places. But the trouble with that kind of breeding is that it does not produce superior individuals. When we come to the greatest men, they are not produced when the breeding is as rapid as three generations to the century. My money offer was for the purpose of finding any possible exception, if it existed."

The only other reply of interest was from Mrs. Elizabeth A. Sourdry of 3404 Morgan street, St. Louis, Mo., who submitted the pedigrees of Wilhelm II, emperor of Germany, William Henry, fourth Duke of Portland, and Charles William Henry, fourth Duke of Buccleuch and sixth Duke of Queensberry. In each case three generations of the ancestry covered less than a century of time. Mrs. Sourdry sent copies of the genealogies directly to Mr. Redfield who in reply wrote her as follows:

"The first objection is that these men are mental mediocrities and not intellectual giants. William II is prominent because he inherited the position of emperor, but he has to his credit no intellectual achievements. If you are going into royalty I think that you should take such men as Augustus, Peter the Great or Gustavus Adolphus.

SOME GREAT MINDS.

"Consider Moses, who not only controlled an unruly mob but who formulated moral laws and regulations which are good after nearly 3,500 years.

"Consider Confucius, whose intellect produced the moral precepts which have guided hundreds of millions for more than 2,500 years.

"Consider Aristotle, who was the main scientific authority for the world for more than 1,000 years.

"Imagine a sickly little fellow sitting in Washington and changing this republic into a monarchy by the sheer force of his intellect. Imagine his influence with Congress being so great that the country would officially confer on him a title certifying the profound respect all entertained for his surpassing wisdom. That would be Augustus of Rome.

"A poor boy without the advantages of schooling became great as an author, great as an editor, great as an inventor, great as a diplomat and great as a statesman; he drew the lightning from the clouds and was honored by all of the scientific societies in the world. That was Benjamin Franklin.

"Humboldt was credited with being an authority in all known sciences. Darwin revolutionized the ideas of the world as to how the different kinds of plants and animals (including man) came into existence. Sitting in his study Leverrier could locate an unknown planet and give its size and orbit. Mendeleef formulated the periodic table and from it predicted the atomic weights and chemical properties of substance then unknown to science. J. J. Thomson has revolutionized our ideas of the constitution of matter.

"My offer related to this kind of men—men who were famous for intellectual power—the greatest intellects

in the world's history. It says intellectually eminent men. The majority of men are produced by breeding faster than three generations to the century, and it is easy to find mediocrities so produced. There are more than 50,000-000 of them in the United States. But can you find a real intellectual giant so produced? Are men like Copernicus, Newton, Faraday, Kant, Goethe, Shakespeare, Milton, Leibnitz, Lao-Tse, Buddha, Mohammed, Loyola, Luther, etc., produced by breeding as rapidly as three generations to the century? I think not.

"The offer in the tail-male line included three cases of four generations within a century. You give that only in the case of Buccleuch. The generations are $20+27+25+26=98$ years."

After considering the two letters, the council of the American Genetic Association decided that no one had submitted data fulfilling the requirements of the offer, and ordered Mr. Redfield's certified check for $200 to be returned to him.

PROF. JOHNSON'S POSITION.

Professor Johnson, whose advocacy of early marriage brought forth Mr. Redfield's challenge, has sent in the following note reiterating his position:

"Mr. Redfield is quite safe in holding that in illustrious stocks the generations are long. It is just this that I contend calls for remedy. To conclude from this, however, that late children are superior mentally is wholly unwarranted. Such late births will still be found to be prevalent with the superior, irrespective of whether late children shall be shown to be equal or superior to early children from the same parents. The reasons for these delayed marriages and births are now too familiar to call for repetition here.

"May I in turn suggest to Mr. Redfield a sound method of testing his hypothesis? Ascertain the number of brothers and the ordinal position among these of all the men in some standard collection of the names of illustrious men which will furnish the desired information. Sisters, owing to the different chance of becoming renowned, and half-brothers and stepbrothers are to be omitted. Compare the age of the parents at the birth of the most illustrious with the average age for his brothers in *each* family.

"But aside from this, even if Mr. Redfield's hypothesis prove correct, it is still true that inferior stocks are producing more early children as well as children in general than are the superior stocks. The mere lengthening of the generations of all stocks will not change the ill-balanced production of the next generation. It is necessary to increase the reproduction of the superior relative to the inferior, no matter to what other device resort may be made. Later marriage of the superior as compared with the inferior is therefore necessarily dysgenic."

Assuming for the sake of argument that the children of young parents are inferior, are they inferior because their parents are young, or are they inferior merely because they are first-born children? Readers will remember that the English Biometric school and other investigators have reached the latter conclusion; others have as strongly denied it. To settle this point, an investigation somewhat similar to the one suggested by Professor Johnson has been set on foot by the Italian Anthropological society.[2] When it is concluded, there should be some adequate ground for holding an opinion as to the superiority or inferiority of the first-born. In the meantime it should not be supposed that the failure of anyone to present such cases of genius produced by rapid breeding as called for by Mr. Redfield, settles the question of the influence of age of parent on quality of offspring. Though one of the most important questions in constructive eugenics, it is a question with many sides, and its solution has only been touched.

[2] Preliminary results of this investigation indicate that first-born sons are as good as their successors, if not better. See "Superiority of the Eldest," by Corrado Gini, in the JOURNAL OF HEREDITY, VI, 1, p. 37, January, 1915. The opposite view, with a brief review of the whole controversy, is given by John H. Chase, "Weakness of Eldest Sons," JOURNAL OF HEREDITY, V, 5, 209, May, 1914.

BREEDING FOR HORNS

Frank N. Meyer[1]

Agricultural Explorer, Office of Foreign Seed and Plant Introduction, U. S. Department of Agriculture, Washington, D. C.

In Birel we stopped with a farmer who had become a wealthy man through the sale of stag antlers, and saw how the women folks were boiling several magnificent pairs. They were all coated yet with the down, which is an absolute necessity to sell them, as the Chinese only take those which are young. This stagkeeping business has its headquarters in and around Birel and by pure accident we had stumbled upon one of the most interesting industries in this world.

It seems that about 40 years ago somebody in Birel made an experiment of keeping some stags in captivity and by sawing the antlers off and bandaging the wounds, showed that a stag can be de-antlered and survive the process and be operated upon every year. Up to that time the animals had been hunted until they were well-nigh extinct and the collecting of antlers was a very unsteady sort of a business, one never knew whether one would get much or not. Well, the animals multiplied and high-fenced enclosures were established all over the mountains, for these stags need much ground to pasture upon, otherwise they don't remain healthy. And today there are several thousand stags in and around Birel and the income derived from the sale of the antlers has made some people very wealthy, for every male animal produces about 70 Roubles[2] worth of antlers every year and some men have as many as 400 males. The average price paid for the antlers is between eight and 12 Rbls. per pound, according to the market.

The antlers are sawn off with a fine saw and weigh fresh twice as much as later on. They have to be boiled in salted water and very great care has to be taken that the felt-like covering doesn't come off; therefore they are boiled several times and each time allowed to dry out again. When sufficiently cooked, they are hung in the wind and allowed to dry thoroughly and in that state they are bought up by dealers and said to be exported to China via Mongolia. The Chinese, as you may know, believe thoroughly in the rejuvenating and stimulative power of young deer horns, and the stuff, scraped and powdered, forms a valuable ingredient in certain of their medicines. I was also told that a firm in St. Petersburg has taken up this matter and is manufacturing a special medicine from them, under the name of "Spermine."

[1] Extract from a letter to his chief, dated Omsk, Siberia, July 17, 1911.
[2] A rouble is worth about 51 cents, U. S. currency.

Corriedale Sheep in United States

F. R. Marshall of the Bureau of Animal Industry, U. S. Department of Agriculture, has returned from the antipodes with 10 rams and 54 ewes of the Corriedale breed, which are now in quarantine at San Francisco, and constitute the first importation of live stock ever made by the department of agriculture. With the exception of six head brought in last year, they are the first Corriedales to be brought to this country. The breed, which originated in the province of Canterbury, New Zealand, in the late seventies, and was long known officially as "inbred halfbreds," resulted from a Lincoln x Merino cross and in part from an English Leicester x Merino cross. It interests the stockman because it offers a combination of wool and mutton qualities, and the genetist because it appears to breed fairly true, in spite of the short time that has elapsed since its formation. In appearance it is very nearly a blend between the two parents, and there seems to be little segregation of characters in the breed at present.

The

Journal of Heredity

(Formerly the American Breeders' Magazine)

Vol. VI, No. 3 March, 1915

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The Journal of Heredity is published monthly by the American Genetic Association (formerly called the American Breeders' Association) for the benefit of its members. Canadian members who desire to receive it should send 25 cents a year, in addition to their regular membership dues of $2, because of additional postage on the magazine; foreign members pay 50 cents extra for the same reason. Price of single copies, 25 cents.

Entered as second-class matter August 27, 1912, at the postoffice at Washington, D. C., under the act of August 24, 1912.

Date of issue of this number, February 25, 1915.

A DWARF MUTANT IN MAIZE

The dwarf mutation illustrated above appeared in a plot of "Stowell's Evergreen" sweet corn grown at the Connecticut experiment station, New Haven, in 1908, and is described in that station's bulletin No. 167, p. 130. "It was very short (18 inches) and had short leaves of the normal breadth. The joints were very close together, and the whole appearance of the plant suggested a normal plant that had been pushed together like a telescope." Its height is shown by contrast with a single ordinary ear from a normal strain of this same variety, at the right. An attempt to self-fertilize the dwarf failed, so it was cross-pollinated from normal Stowell's Evergreen, and produced one fairly good ear, which was planted. One dwarf like the maternal parent appeared out of 37 plants. From a Mendelian viewpoint it might have been expected that there would be no dwarfs in this generation, but that the normal condition would be dominant. The one dwarf was completely sterile, but a selfed normal plant from the same lot gave two dwarfs out of 76 plants in 1910. E. M. East writes, "I suppose that it is an example of variable dominance such as is often found when one crosses an abnormality with a somewhat mixed population. As every race of corn is more or less mixed, I think it not unlikely that many of these abnormalities should vary all the way from the dominant to the recessive condition in the first hybrid generation of the cross. It is not a peculiar result, but is apt to confuse a person in an open pollinated crop like corn." (Frontispiece.)

ON THE NATURE OF MUTATIONS

Their Cause to be Sought in a Chemical Rather Than Morphological Change in Some Chromosome—New Material Furnished for Evolution—Data from the Evening Primroses.[1]

DR. R. RUGGLES GATES, *University of London.*

EVER since the beginning of the twentieth century, when the principles of Mendel were rediscovered and DeVries published his mutation theory, the nature of the changes which give rise to mutations and to Mendelian differences has been much discussed. For it is obvious that our views on these questions will determine our attitude toward evolution in so far as it is concerned with discontinuity in variation. Mendelian investigators have for the most part assumed that the main point to be discovered is the manner of inheritance of the Mendelian differences found in plants and animals, and have failed to observe that the *origin* of these differences is a wholly different question, requiring in many cases other methods of attack.

It has also been tacitly or speculatively assumed that mutations were in some obscure and hypothetical way the expression merely of new combinations of Mendelian units. This view, or rather group of views (for each Mendelian writer has attempted a different hypothesis, such as reduplication of gametes, coupling of characters, multiple factors, loss of inhibitors, etc.), has only recently been exploded. But it is worth while pointing out that even if this were not the case it would still be necessary to account for the origin of the supposed Mendelian differences. This Mendelian writers have attempted to do by means of the presence-absence hypothesis. But it will be shown later that the latter hypothesis has had placed upon it a far greater weight of speculation than it is able to bear.

The activities of recent years in the study of mutations have, on the contrary, accumulated a mass of positive observations concerning the real nature of mutational changes. These investigations have combined cell studies with observations of the external characters of mutants and their hereditary behavior, both in self-fertilized offspring and in crosses with their parent forms. In this way much light has been thrown upon the nature of mutation as a process of variability. It has been definitely shown that mutation is a type of variation and cannot be explained in terms merely of heredity, Mendelian or otherwise. The cell studies of mutants in particular have been crucial in eliminating the various Mendelian hypotheses of mutation, for the latter are found to be directly contrary to the cytological facts. These facts have also made it possible to construct a new theory of mutations in general which helps to illuminate the whole subject and harmonize the Mendelian and mutationist views.

We are thus led to adopt a new attitude toward the subject of heredity as well as that of variation; the latter being concerned with the origin of differences between related organisms, while the former is concerned with the perpetuation of those differences after they have originated.

EVIDENCE FROM THE PRIMROSE.

The critical and decisive experiments concerning the nature of mutations have, as is well known, been made in the evening primrose genus Oenothera. Here the numerous attempts to explain the origin of the mutants in terms of the recombination of Mendelian factors have broken down. For a number of years it has been assumed in various

[1] Presented before the Botanical Society of America, Philadelphia, Dec. 30, 1914.

LAMARCK'S EVENING PRIMROSE

This common flower is supposed to be a native of the central eastern portion of the United States, but was early introduced to Europe and is now found wild there in many localities. The Dutch botanist Hugo de Vries found a number of them in a field near Hilversum, Holland, which were undergoing unusual changes in form. He brought them to his garden, propagated them, and found that these changes were continually produced, that some of them were very great, and that most of them bred true. This was the starting point of the Mutation Theory which marks an epoch in the study of evolution. (Fig. 1.)

AN EARLY DISCOVERED MUTANT

Rosette or young seedling of *Oenothera lata*, a mutant from *Oenothera lamarckiana* (shown in fig. 1), which was discovered by De Vries as early as 1887. Even the youngest leaves have broad, rounded tips, in contrast to the more pointed ones of the parent form, and the leaves are also more crinkled. It has been shown that the cells of this plant contain an extra chromosome not present in those of the parent, and it is this, apparently, which determines the nature of this mutant. (Fig. 2.)

quarters that *Oenothera lamarckiana* was a "hybrid," although it has usually not been stated in just what sense this term was used. More recently all Oenotheras have been stigmatized as hybrids, and the conception has even been extended to the whole family of Onagraceae. It seems that this is the fate of all organisms which come to be intensively studied from the genetic point of view.

Having regard to the facts, it is not necessary to suppose that any recognized species of Oenothera is a hybrid in the sense of having been synthesized directly through crossing between two other species. An extraordinary flaw in all the reasoning in this subject has been the tacit assumption that if any plant could be shown to be a "hybrid" then any mutations it might produce must be a result of that condition. But it is necessary to point out that even if the assumption that all Oenotheras are

hybrids were true, it would still be necessary to inquire whether the types of variation found in *Oe. lamarckiana*, *Oe. biennis*, *Oe. grandiflora*, and other species are merely the result of hybrid processes, or whether mutation and hybridization are distinct processes.[2]

MISSHAPEN BUDS

The petals in the bud of *Oenothera lata* are crumpled, causing it to be misshapen; the anthers are sterile or nearly so, and relatively few seeds are produced. The buds are stouter and more barrel-shaped in this mutant than in any of the other forms except *gigas*. These buds are natural size. (Fig. 3.)

The cell studies of the Oenotheras have abundantly proven the latter view. The nature of the explanation of mutations is also very usefully limited as well as illuminated by the cytological results. Mutations of course occur in hybrids as well as in pure strains, and it is usually possible without much difficulty to pick out the mutants in heterogeneous F_2 hybrid families. Confirmation of many such cases can afterward be made by cytological study, and others can be analyzed by breeding from them.

As illustrations of the new point of view with regard to mutations we may select three of the mutants of Oenothera. A flowering shoot of *Oe. lamarckiana* is shown in fig. 1. The mutants, *lata*, *gigas*, *rubricalyx* are all derived from this species, the last, however, being a secondary mutation, which originated directly from *rubrinervis*, itself a mutant from *Oe. lamarckiana*.

OENOTHERA LATA.

In this mutant and certain others, duplication of a chromosome has taken place, and the writer showed some years ago[3] that this happens through one chromosome of a pair passing into the wrong nucleus in the reduction division. It is now known[4] that *lata* has constantly 15 chromosomes instead of 14 in the nuclei of all its cells. Fig. 2 shows a rosette of *lata* with its deeply crinkled and peculiarly obtuse leaves. This mutant also has a peculiar habit of growth, and its buds are misshapen (fig. 3), the anthers being almost completely sterile. Various other features characterize this very interesting form which was first discovered by De Vries as early as 1887.

Not only is the extra chromosome constantly associated with these peculiarities of *lata*, but its presence determines the inheritance of *lata*, for its offspring consist chiefly of *lata* (with 15 chromosomes) and *lamarckiana* (with 14 chromosomes) in varying proportions. *Oe. lata* appears in different races and species (including *Oe. biennis*) when this irregular meiotic division occurs. The peculiarities of *lata* thus arise from the fact that its nuclei contain 15 instead of 14 chromosomes. This condition arises in the fertilized egg and is passed on to every cell of the plant by the mitotic mechanism.

[2] See Gates, Breeding experiments which show that hybridization and mutation are independent phenomena. Zeitschr. f. Abst. u. Vererbungslehre 11: 209–279. Figs. 25.

[3] A study of reduction in *Oenothera rubrinervis*. Bot. Gazette, 46:1–34. Pls. 1–3.

[4] See Gates and Thomas. A Cytological study of *Oenothera* mut. *lata* and *Oe.* mut. *semilata* in relation to mutation. Quart. Journ. Micro. Sci. 59:523–571, pls. 35–37, figs. 4.

THE GIANT PRIMROSE

Rosette of *Oenothera gigas*, another mutant from Lamarck's species. The leaves are larger and thicker and with rather blunt tips. With the exception of a few features, this sport breeds entirely true. Reduced in size in reproduction. (Fig. 4.)

The mutation is therefore a nuclear change, which is represented in every cell of the organism, and it will be found that the same is true of every mutation, at least in plants. They are germinal changes of such nature as to be represented in every cell, having been propagated by mitosis from the fertilized egg.

OENOTHERA GIGAS.

This mutant represents another kind of germinal change—tetraploidy. A rosette of *gigas* is shown in fig. 4 and full grown plants in fig. 5. The plant is larger and stouter in nearly all its parts, except in height. There are various other modifications from *Oe. lamarckiana*, as in the shape of the leaves, and a striking feature is the presence of four-lobed instead of three-lobed pollen grains—a condition not known to occur in any other evening primrose. Many of these peculiarities, though perhaps not all, result from the tetraploid condition,—the nuclei contain 28 instead of 14 chromosomes and as a result the nuclei and cells in all tissues of the plant are conspicuously larger.[5]

The doubling in the chromosome number, however it has taken place, is a distinct process from the irregular chromosome-distribution which gives rise to the *lata* type of mutation, for in this case the whole chromosome series has been doubled. Tetraploidy is now known in a long list of plant and animal species, which must have originated suddenly from a related species, in the same manner that *Oe. gigas* appeared. Here again the change is a cell change, propagated by mitosis to every part of the organism.

[5] Gates, R. R. The stature and chromosomes of *Oenothera gigas* De Vries. Arch. f. Zellforschung 3: 525–552, 1909.

ADULT PLANTS OF THE GIANT MUTANT

Its difference in habit from *Oenothera lamarckiana*, the parent form, may be seen by comparison with fig. 1. There are usually few side branches, the internodes are short, and the large, deeply crinkled leaves tend to hang downward on the stem. The flowers are larger and the buds stouter than in the parent form. It has been found that the cells of this mutant contain twice as many chromosomes as those of the parent, a fact which perhaps accounts for the increased size and vigor of this sport. From a photograph kindly loaned by Dr. B. M. Davis. (Fig. 5.)

A DIFFERENT TYPE OF MUTANT

Oenothera rubricalyx originated in the breeding-plot of Dr. Gates in 1907 and is quite unlike all the other primrose mutants. It did not spring directly from Lamarck's primrose, but from a mutant of it, *Oe. rubrinervis*. In the mutant here shown the under sides of the leaves, and the flower stalks, are red, whereas in the parent they are green. Dr. Gates assumes that some chromosome in the reproductive cells has undergone a chemical change, which leads to an increased production of red pigment, and thus to the mutation. (Fig. 6.)

Another interesting fact concerning *gigas* is that its inheritance is entirely different from that of *lata*, since *gigas* breeds true except for remarkable variation chiefly in foliage. This variability is probably concerned with new combinations of the double chromosome series. In crosses also *gigas* behaves differently from *lata*, giving intermediate hybrids which essentially breed true. This difference in behavior of *gigas* and *lata* is undoubtedly concerned with the different chromosome content of the two forms, and is explainable in terms of those differences.

If now we consider *rubricalyx*, we find the type of change entirely diverse from either of those mentioned above.

THE RED MUTANT, FULL GROWN

Adult plant of *Oenothera rubricalyx*, a young seedling of which was shown in the preceding illustration. The number of chromosomes in its cells is 14, as in those of its parent; Dr. Gates therefore argues that the origin of the mutation must be chemical in nature, and not morphological. (Fig. 7.)

This mutant originated from *rubrinervis* in my experiments in 1907, as a dominant heterozygous mutation, its offspring giving *rubricalyx* and *rubrinervis* in a 3:1 ratio.[6] It is a striking color variety of *rubrinervis*, the two being morphologically identical. A rosette of rubricalyx is shown in fig. 6 and a full grown plant in fig. 7. In *Oe. rubricalyx* the under side of the leaf petioles of the rosette as well as of the flower stalks or hypanthia, are red, whereas in *rubrinervis* they are invariably green.[7]

In *rubricalyx* there is also greater production of red pigment in every part of the plant, as may be observed by examining sections of the fresh tissues under the microscope. The capacity of the cells for producing anthocyanin has suddenly undergone an enormous increase.

Any theory which will explain the origin of *Oe. rubricalyx* will explain also the origin of all Mendelian differences, for this is inherited in simple Mendelian fashion, wholly unlike either *lata* or *gigas*.

If we assume that one member of one pair of chromosomes has undergone a chemical change to lead to the greatly increased pigment production, then we can explain at the same time the origin and inheritance of this mutant. We therefore conclude in general that simple Mendelian characters arise through an alteration on the part of a chromosome, analogous to the mutations which are known to occur in certain bacteria.

This type of change is of course entirely different from those already mentioned, and is sufficient to account for the origin of all mutants which are inherited in Mendelian fashion. The change is fundamentally chemical rather than morphological in nature, the chromosomes in *Oe. rubricalyx* numbering 14, as in *Oe. lamarckiana* and *Oe. rubrinervis*.

From such facts as these the following conclusions regarding the nature of mutations may be drawn. (1) Mutations are of many kinds and in many directions. (2) Evolution is not due, as Bateson[8] and others have urged, to the loss of factors or inhibitors from the germ plasm, but mutations furnish abundant material for real evolution, in which the modification of characters, and divergences in many directions, have occurred. There is really no more reason for supposing evolution to have resulted from "loss of inhibitors" from the germ plasm than there is for the embryologist to assume that the egg develops into a chick by throwing off inhibitors during ontogeny. This type of embryological speculation was supplanted centuries ago by the observed increase in complexity and structure during development of the individual.

The evolutionary conception of loss of factors and inhibitors has been founded upon the Mendelian presence-absence hypothesis. The usefulness of this symbolism in the study of the inheritance of Mendelian characters cannot be gainsaid. But as soon as it is applied to evolutionary conceptions it leads to an erroneous point of view. It is safe to conclude that even apparent losses, such as the origin of recessive white varieties from colored varieties of plants and animals, are not really due to the loss of any particle from the germ plasm, but to a chemical (probably in some cases stereochemical) modification in one element of the germ plasm, viz: a chromosome or a portion of one.

(3) Finally, another generalization should now be seen to follow clearly from such facts as those mentioned in this paper, namely, that the inheritance of any character depends to some extent upon the nature of the character. In other words, the manner of inheritance of any character is determined, or

[6] Shull (A peculiar negative correlation in *Oenothera* hybrids. *Journ. Genetics* 4: 83–102, pls. 5–6, 1914) has erroneously attempted to show that *Oe. rubricalyx* is not a simple Mendelian dominant. The plants in his experiments which he treats as pure *rubricalyx* are obviously, from his own figures, hybrids with a distinct species *Oe. grandiflora*, and the supposed discrepant results he obtains are in fact, as far as they go, a confirmation of the writer's extensive crosses of these two forms.

[7] The history of the origin of this mutant is given in "Studies on the variability and heritability of pigmentation in Oenothera." Zeitschr. f. Abst. u. Vererbungslehre 4: 337–372. Figs. 5. 1 colored plate, 1911.

[8] Problems of Genetics. London, 1913.

at any rate limited, by the manner of its origin, *i. e.*, by the nature of the germinal change by which it appeared. Just as there are different types of discontinuity in variation, so there are various methods of inheritance of the differences which thus arise. These methods of inheritance naturally depend upon the basic nature of the original change.

ANNUAL MEETING OF THE ASSOCIATION

THE annual business meeting of members of the American Genetic Association was held in the Cosmos Club, Washington, D. C., at five o'clock on the afternoon of Thursday, January 14, 1915, as provided by the by-laws.

The three retiring members of the council were re-elected by the following motion, carried by a unanimous vote: "Resolved, that the secretary be instructed to cast the unanimous ballot of this meeting for Alexander Graham Bell, W. E. Castle and Bleecker Van Wagenen to succeed themselves as members of the council of this association; and that this action is not to be considered a precedent, but is considered fair because the three retiring members have served one year only, and not the normal term of three years."

The meeting approved the plans of the council to hold the annual convention of the association at Berkeley, California, August 2–7, in connection with the meeting of the American Association for the Advancement of Science.

At the annual meeting of the council, held at the Cosmos Club at 5 o'clock on the afternoon of Tuesday, January 19, in accordance with the by-laws, the present officers of the association were all re-elected, and Thomas H. Kearney was elected a member of the executive committee for the ensuing year, the other two members being the president and secretary, *ex officio*.

Conditions of Mendelian Inheritance

If we take "Mendelian inheritance" to signify the mode of inheritance Mendel found to prevail in his researches on seven differentiating characters in peas (except that perfect dominance need not be present), the following are some of the complications which must be absent in order that *simple* Mendelian inheritance may appear.

1. Each single factor must pass indifferently into half of the pollen-grains and half of the embryo-sacs. There must be no such *multiplication* of factors as occurs in the origin of some giant Primulas and Œnotheras.
2. There must be no such coupling or repulsion between the factors as has been found in sweet peas, primulas, snapdragons, peas, and velvet beans.
3. There is usually some elimination of pollen-grains and embryo-sacs; but there must be no elimination that has any relation to any of the factors in question, such as occurs in certain Stizolobium hybrids, and doubtless in Œnotheras.
4. There must be no inherited difference in the fertilizing power of different "good" pollen-grains from the same anther. If a definite fraction of the pollen-grains fail to fertilize the ovules (as Correns found in Mirabilis), then a selective *partial* self-sterility, or *partial* incompatibility occurs, which may complicate the results.
5. The death of certain embryos within the ovules or young seeds (which seems to occur in most plants), must not be due to any *inherited* weakness of these particular embryos.
6. There must be no such differential viability of the seeds as has been found in double stocks by Saunders, and in *Œnothera lamarckiana* by DeVries.
7. If a definite fraction of the young seedlings perish unnoted, this will make abnormal ratios, as occurred in Baur's first experiments with the golden-leaved snapdragon.
8. Plants which die before maturity must not do so from inherited weakness, or the final ratios may not be typical.

Mendel's law is only the alphabet of the subject of heredity. The simple law of gravitation is also easy to grasp, but much work of many astronomers was required to fit this law to the actual motions of even one planet. I think that heredity may be found, in the end, to be nearly as complicated as astronomy.

John Belling, *Florida Agricultural Experimental Station.*

GERMAN ZOÖTECHNY

Immense Strides Made by Live-Stock Industry of the Empire are Largely Due to Science of Genetics—The Importance of the Pedigree—Line-Breeding.

Review of a book by GEORG WILSDORF

Tierzuchtdirektor und Hauptgeschäftsführer der Deutschen Gesellschaft für Züchtungskunde, Berlin, Germany.

GERMANY'S large contributions to the science of genetics during the last half century are well known, but the extent to which they have been put to practical use by the Germans themselves is much less familiar to Americans. Some of the brilliant work in plant breeding is indeed recognized; but it is probable that few members of this association have any clear idea of the present state of the science of animal breeding in the German empire. It may be of interest, therefore, to review at some length a brief but authoritative statement of the situation from the pen of Dr. Georg Wilsdorf, general director of the influential German Genetic Association.

Dr. Wilsdorf's little book on Animal Breeding[1] was first published in 1912 as one of a series of popular hand-books on scientific subjects. In 1914 it was reissued as a bulletin of the German Genetic Association; it seems reasonable to assume, therefore, that its doctrines are those accepted by the leading zoötechnists of Germany.

The live-stock industry of Germany (reaching its highest development in the northwest) has increased until it now surpasses the agricultural and horticultural industries in importance, according to Dr. Wilsdorf, who estimates the yearly production of animal husbandry at $1,675,000,000 as against $1,300,000,000 for the produce of field and garden. And while he recognizes that this gradual preponderance of live-stock over the agricultural industries has been largely due to economic conditions, he thinks it has only been made possible through an intelligent application of the principles of genetics. The demands made by the farmers on science have, he says, changed the whole character of zoölogy in Germany; while the zoölogists formerly concerned themselves almost exclusively with wild animals, the tendency now is rather to concentrate attention on the domesticated ones.

A CHANGED VIEWPOINT.

But the studies of zoölogists and the experiments of naturalists on zoötechny can easily be credited with more influence on the live-stock industry than they really have had; for, as the author points out, the fundamental fact in the successful application of genetics to animal breeding is not the discovery of any new law, but a change in the viewpoint of breeders. In the past, they have looked only at the generation or two before their eyes; the acquirement of a habit of looking as far back as possible, instead of merely at the animals immediately to be mated, is what has revolutionized animal breeding. In other words, it is the realization of the importance of the pedigree that has made animal breeding a science rather than an art. Such a statement might justly be considered the text of Dr. Wilsdorf's book, for to it he returns time after time.

The importance of pedigree above everything else was realized by the Arabs centuries ago, but is still ignored by many a breeder in Europe and

[1] "Tierzüchtung" von Dr. Georg Wilsdorf, pp. 110, figs. 23, price one mark, bound in linen M. 1.25; Bändchen No. 369 "Aus Natur und Geisteswelt" sammlung, B. G. Teubner, Leipzig, 1912; 17th Flugschrift der Deutschen Gesellschaft für Züchtungskunde, Berlin, 1914.

America. It is being emphasized on both continents, however, by the development of breeders' association and herd and stud books, with the subsequent premium put on accurate registration. In Germany the development of these instruments has proceeded on much the same lines as in America, but there has been more coöperation between the promoters of different breeds —a coöperation largely brought about by the huge and powerful German Agricultural Society, whose 18,000 members represent the advanced element in scientific agriculture in the empire; and largely directed by the German Genetic Association, whose principal function is the registration of pedigrees and their subsequent study. It is chiefly as a result of the work of the latter, Dr. Wilsdorf says, that sentiment in Germany has been changed on the subject of line-breeding. The verdict of the older school of zoölogists had been against it, but impartial examination of horse pedigree charts by Lehndorff and others convinced them that much of the progress made in the live-stock industry was due to line-breeding, and they began to recommend it. Then the value of a "genetic analysis" of each animal came to be realized—that is, an examination of its ancestry to determine how it should be mated. A good example of the way pedigree study can be put to use is his description of the work of the famous zoötechnist Dr. de Chapeaurouge at the national stud farm in Celle. He brought together pedigrees of many of the Hanoverian stallions there and found that the stallion Nording got good colts in some districts, but very poor ones in others. This fact had been recognized by the Celle breeders, but its cause was a complete mystery. Testing theory by fact, de Chapeaurouge was able to prove that the good colts were regularly produced when Nording was mated to a mare with which he was related. As the mares in his own particular district were much more likely to be related to him than were mares of more remote districts, the result was that he had been getting valuable colts in that district and comparatively worthless ones whenever he went out of it—a result that would have remained a mystery, had it not been demonstrated that the principle of consanguineous breeding was sufficient to explain it.

CONSANGUINITY WIDESPREAD.

The amount of consanguinity among the domesticated animals of any district is, as Dr. Wilsdorf points out, easily under-estimated. "Suppose we take, as illustration, a valley in which there are 50,000 head of stock of any given kind. If this number of animals had only parents, grandparents and great-grandparents which were unrelated to each other, then we would have—reckoning 14 ancestors for each animal—700,000 unrelated animals as ancestors of these 50,000. If one tries to find out whether such a condition could actually exist in practice, and examines the pedigree book of some large herd, he finds the actual number of ancestors is immensely smaller than calculation led him to expect. The same animal will appear over and over again in the ancestry of a given individual, so that most of the animals now living trace back to numerous common ancestors. In the herd which we have taken as an illustration, we would not find 700,000 ancestors, but perhaps half that many, or even less.

"In our studies of the history of various breeds, we next made the astonishing discovery that the best living individuals belonged to families which, when their pedigrees were traced, were found all to come from a single family—often from a single individual. By way of illustration I might cite the Hanoverian halfbloods, which we know particularly through the studies of de Chapeaurouge and Grabensee to have come almost altogether from three stallions, of which Norfolk has hitherto had the greatest influence on the breed—an influence that is increasing all the time. Researches into the swine breeding of the Visselhövede district, and into that of Hildesheim in Bavaria, have shown that in each case a single boar was the ancestor of various valuable families, today widely scattered. And Hoesch of Neukirchen has found that his valu-

able strain of swine is principally due to the blood of a single early boar Richard."

This means that the origin of most of the valuable strains of live-stock in Germany has been due to line-breeding —and the same is true of any other part of the world. The value of such breeding was known to the Greeks and Romans, but after their time it fell into great disrepute, partly from theological reasons, and until recently, the author says, it was considered not only a questionable, but a distinctly dangerous procedure in Germany, while even today many a breeder will pay a higher price for an animal if he feels sure that it is not related to any now in his herd. "The modern science of breeding, however, stands firm in its belief that for the production of definite types for special purposes in-breeding is the quickest and most certain method of procedure, and all great breeders who work toward any particular goal depend largely on inbreeding, knowingly or unknowingly."

REVERSION OR ATAVISM.

A certain amount of inbreeding is undoubtedly necessary to preserve the type of any purebred strain of stock; conversely, the quickest way to break up the type is to mate with some widely differing animal. Even if the mating be between animals which look exactly alike in respect to any given character, that character will frequently disappear altogether in the offspring and be replaced by some character presumably belonging to the breed or species very early in its history: this is the phenomenon of atavism, reversion or "throwing back." It is particularly common in our domestic animals because, as Dr. Wilsdorf points out, most of them seem to be the product of the union of several different races or even species, at some remote time in the past. The result of such mixture is seen in an interesting case he cites, of the herd of white cattle owned by the King of Württemberg and kept in Rosenstein Park near Stuttgart. "Here a pure white herd has been bred for many years, and new pure white males of many breeds (Schwyzer, Allgauer, Simmentaler, Limpurger, Swabian Haller, Hollander, East Friesian, Shorthorn, Alderney and Zebu) introduced at intervals. But although no animal which was not white has been introduced, so far as is known, since the herd was established, a number of calves are born each year which are not white, but some other color."

Most existing breeds of live stock probably have an origin not very much less mixed than that of the King of Württemberg's white cattle: the mixture was made at a more remote period, however, and its complexity is therefore not so vividly realized.

With material of that sort to work on, it is evident that the task of the modern breeder is one of great delicacy. His chief object is to produce animals that are all of one type; and yet the very make-up of his stock makes it inevitable that nature will constantly strive to break away from that artifical type and return to the more primitive characteristics. How shall the breeder thwart this effort of nature?

As suggested above, he does it by line-breeding, that is, by breeding in one blood-line as much as possible— "pure breeding." The so-called "purebred" animal, then, has been produced by line-breeding more than by any other factor.

"Strictly speaking, any introduction of foreign blood would result in the breed no longer being 'pure.' But frequently it is to the interest of the breed to introduce a new blood stream, that is, new and valuable characteristics. Speaking by and large, one cannot then say that the breed is no longer pure; the word 'purebred' is relative, not absolute, in its meaning. Our producers of purebred stock frequently speak of 'crossing' when they employ stock for breeding which is not quite their ideal in type. Here again the idea of 'purebred' is pretty narrowly construed. The practical breeder understands it more broadly: for him the mating of animals of the same type is pure breeding."

To sum up, the triumph of scientific animal breeding has consisted in the suppression of natural diversity and in breeding animals true to a fixed type: the study of pedigrees and the utiliza-

tion of the information they gave by means of line-breeding have been the chief instruments of the scientific breeder.

FIXING THE STANDARDS.

It will be obvious from this that nothing is more important than to have a satisfactory fixed type. If our standard is wrong, then increase in skill in breeding, improvement of the technique, is of little value. The geneticist's ability to use the laws of heredity will be of little avail, unless the standard toward which he is breeding is as good as science can define. Dr. Wilsdorf therefore emphasizes the great advance that has been made in this direction in Germany as in most other parts of the world during recent decades. It was not long ago, he points out, that breeding was merely a matter of mating two animals, without much regard either to their pedigrees or to their performances. Now it is recognized that these two factors must go together, each supplementing and interpreting the other; and the development of performance tests has therefore become a part of the breeder's work not only important but absolutely necessary. In horse breeding, the race track justifies itself largely on this ground; horse shows do, too, when the practical element is not wholly submerged by the sporting element; while endurance tests and work tests for the heavier horses are now being developed, particularly at the national stock farm of Warendorf, where the annual "Warendorf Week" draws draft animals from many regions, to be submitted to tests of hauling cars loaded with sand, that will give any competent judge a good idea of what kind of a constitution they have inherited and are likely to pass on to their offspring.

Cattle breeders took up the idea of performance tests far later than horsemen did, for in earlier times cattle were largely valued as draft animals, and milk production was an insignificant side issue. During the last century, however, the development of the milking function, through conscious or unconscious performance tests and selection of the best producers for breeding, gave marvelous results. The average yield of German cows at different periods is stated by the author in the following table:

1790........	¾ quart
1800........	1½ quart
1810........	2 quarts
1820........	3 quarts
1830........	4 quarts

This quantity was maintained for three decades. Then, with the collapse of sheep breeding in Germany, dairy cattle again received an unusual amount of attention, with the result that the figures were increased to:

1860........	6 quarts
1870........	8 quarts

From this point on, the physiological limit began to appear in sight, and the increase was necessarily slower. But the nearer the physiological limit came, the more careful were breeders to test and select only the finest milk-yielding strains, with the result that at the beginning of the twentieth century, Dr. Wilsdorf thinks the average daily milk production of German cows may be placed at 10 quarts. In one century, their yield was increased more than 1000 per cent. by intelligent breeding—certainly as good an example as one could ask of the practical value of genetics.

FORM VS. REAL VALUE.

Production tests for beef cattle, on the other hand, have helped to make clear to breeders the difference between bodily and germinal qualities. There was a period when the study of type was the prevailing fad, and when it was believed that if you had animals conforming to a certain ideal beef type, you would have ideal animals to breed from as well as to butcher. This gave rise to a number of herds that were very pretty to look at, but caused disillusionment later on, for as the writer tersely says, Handsome is as handsome does:—"The level-headed farmer properly considers an animal beautiful, when its production is beautiful." It was soon found that bad form and considerable departures from the ideal type might be associated with

first-class production-capacity, and this brought home a realization of the fact that the latter quality was a matter of inheritance, and might or might not be identified by the "show form" of the animal in question. Now the practical breeder spends more time studying pedigrees and less in measuring the relative proportions of the parts of his animals; "for if an animal has nothing more to show than a beautifully proportioned body, and is a second-class producer, there is no room for it in practical animal husbandry." After 40 years of careful tests, made possible by the invention of suitable apparatus, the dairyman knows that the family to breed from is the one that yields the best quantity and quality of milk, not the one that produces calves most like the pictures in some "Standard of Perfection."

During all this time an effort was being made to find some connection between form and capacity—to find correlations, as the professional genetist would say, between some features of the body and the milk yield. One after another was advanced; many writers established imaginary "milk types," some of them on the most unbelievable grounds. "It has not yet been proved," in Dr. Wilsdorf's opinion, "that any certain characters or forms give any reliable indication about the milk yield of a cow." He does not hold it impossible that such correlations may eventually be found, but points out that the careful experiment of Gaude with nearly 1,000 cows in East Friesland showed "that the influence of such factors as feed, work, care, pasturage, etc., caused so much change in bodily conditions as to make the probability of recognizing 'milk indications' very unlikely."

Of all civilized countries, Germany has the greatest number of breeds of cattle—probably a hundred, many of the smaller of which are now dying out. But only in two places are the herd books sufficiently full and ancient to make pedigree breeding satisfactory: among the Shorthorn breeders, and in East Friesland where the Holstein-Friesian cattle are bred. In the latter district, the records show that most of the good animals trace back to one of a very small number of good bulls: "Primus," "Matador," "Bernhard," and "Max."

PRACTICAL PEDIGREE STUDY.

"How important pedigree study is may be illustrated by an experience of my own. For 12 years I have been a member of the live-stock purchasing committee of the Brandenburg Board of Trade in East Friesland, and at the very beginning of my activity learned that a promising looking black and white bull in one district of the province of Brandenburg, although bred to excellent cows, got offspring of mediocre value, both in form and in color. Investigation showed that the bull was from a herd of black cattle in East Friesland, which a few years before had been 'graded up' from a herd of brown cattle. This fact, extraordinarily unfortunate for the breeders of the district in which he was located, gave me occasion to begin investigating personally the pedigree of every sire which was thereafter brought into the region, and to require from owners of calves by him periodical reports in the future. I checked up these reports at every sale of East Friesian cattle and in the course of a few years had satisfactory evidence as to the breeding value of practically every important strain of cattle in the region, so that little by little we were able in our yearly purchase to get cattle of greater breeding value into the province. What we did must be done sooner or later by the breeders of every other district: they must find out the actual value of all stock offered them, from a genetic point of view."

While science has been applied to horse and cattle breeding with results highly gratifying to German pride, the sheep breeders seem to have fallen behind. Lack of careful selection, and inbreeding of bad animals rather than good, are blamed in part for the ruin of the industry—among other troubles, it is stated that a failure to select fecund strains led to a decline of fecundity in German sheep

In swine breeding, too, science has made slow progress; but as successful swine breeding is easier than successful sheep breeding, Germany still holds an important place in this field. Most of the swine are in the hands of small breeders, among whom there is a widespread prejudice against line-breeding; this leads to the constant introduction of foreign blood and the result is a failure of the herd to improve, or frequently an absolute deterioration of the strain.

An example of the changes that may be made by systematic breeding is offered by the widespread goat industry of Germany. In the last 20 years the goats of the empire have almost wholly been changed from horned to hornless, by the introduction of hornless Swiss breeding stock. The same cause has led to the disappearance of the old colors and their supplanting by white and brown.

Turning to a consideration of the formal laws of heredity, Dr. Wilsdorf shows himself to be a conservative. He frankly recognizes that most of the knowledge now in the possession of animal breeders on this subject is the result of the research of plant breeders, and he sees no objection to this state of affairs, since it is now pretty generally admitted that, on the whole, the laws of heredity that apply to one section of the living world apply to others as well. He further recognizes that formal laws of genetics as yet can give little real help to the animal breeder.

MUCH YET TO BE LEARNED.

"When the architect builds a house," he writes, "he can say in advance, 'The house will be like this: it will have such and such a height, such and such a shape,' and so on. The gardener who has to lay out a garden or park can tell in advance just how the result of his work will look. He picks out the places where the paths will run, where turf will be planted, where flowers will appear; and he can say to himself, 'In this place such and such a tree will grow.' Architect and gardener alike know beforehand how the finished product of their work will look; but not so the animal breeder. He is dealing with laws of nature which are not yet well enough known to enable him to predict with absolute certainty how they will work. One knows well enough that the offspring of two parents usually is like them, but whether it will more resemble the father or the mother can not with certainty be foretold. Exactly in this uncertainty lies the difficulty of the animal breeder's work. It has therefore long been the aim of experimental breeding and particularly of experiments in hybridization, to find certain rules with which heredity complies. We are well aware that there are animals which transmit their characteristics with unusual prepotency, and we can say with a good deal of certainty that the product of most of these animals will have a large proportion of those characteristics. But frequently enough comes a case where we are deceived, and the number of cases in which we can speak of a 'rule' is proportionately very small: the part of the breeding industry in which we still walk in uncertainty is much larger than that in which we can advance without groping.

"The search for these rules, however, has occupied a great number of naturalists during recent years, and still occupies them. The work hitherto accomplished is a great one and, even if the goal is still a long distance ahead, we have nevertheless taken a big step forward. Plate distinguishes four different methods of heredity, as follows:

1. Mosaic heredity.
2. Blending or intermediate heredity.
3. Mutational heredity.
4. Alternative, segregating or Mendelian heredity.

"In mosaic heredity the characters of the parents exist side by side in the offspring—as in a mosaic. As example I may cite the barred progeny of white and black fowls bred by Davenport; or the color of the well-known Blue Andalusian fowl, where the pigments black and white, intimately mixed, produce an apparent blue color. Hilzheimer cites the Baldinger Tiger Swine as an example of this sort of heredity: it was produced by crossing the white native race with the black Berkshire.

"The second method of heredity is the blending. In it the characters fuse together so that the product stands half way between the two parents. The mulattoes resulting from crosses between negroes and whites may be cited in this connection: their color is constant in succeeding generations.[2]

"In mutational heredity a form appears in the first generation which was not present in either of the parents. As an example genetic literature usually cites Bateson's cross of fowls with rose comb and fowls with pea comb; the offspring had a walnut comb—that is, an entirely new form; which however, could not be bred pure in succeeding generations, but segregated in the second generation, in the following proportions: 9 offspring had a walnut comb, 3 a rose comb, 3 a pea comb and 1 a single comb."

THE VALUE OF MENDELISM.

More important than these to the breeder of live-stock is the fourth method, Mendelism, Dr. Wilsdorf says, but after he has explained it at some length, he feels obliged to conclude:

"Now if we ask ourselves what importance Mendelism has for practical animal breeding, we must admit at the very outset that the development of the rule is still too new to admit of sure conclusions. In this day no one is likely to deny that a thorough knowledge of this rule, which solves so many problems that before its discovery were absolute mysteries, is of the first importance. In agricultural animal breeding, however, we are confronted by one almost insuperable difficulty—that our most important domesticated animals bring only one offspring into the world at a time; whence the conditions of heredity are naturally not easy to observe. It is only with such animals as swine, which produce larger numbers of young at a time, that one can derive much immediate help from Mendel's Rule."

Furthermore, he points out, "it is by no means assured that *all* characters Mendelize." On the whole, he considers Mendelism an instrument of great future promise, but one which is hardly likely to be of much value to the practical breeder at the present day.

Telegony and maternal impressions are mentioned as supposed factors to which many breeders ascribe unexpected variation. As Dr. Wilsdorf says, these can no longer be considered anything but superstitions, yet they are still widely held. "In East Friesland, the Eldorado of the German cattle industry, many breeders still believe heart and soul in the power of maternal impressions on the cow. If a red or red-and-white calf is born in a herd of solid black-and-white color, the mother must have looked at some red object. You can argue as much as you like, this explanation can not be shaken in East Friesland. And yet the true explanation lies right under their noses! either the neighbor's herd is red-and-white, and one of his bulls has jumped the fence, or else it is a case of atavism such as I have already spoken of. A belief in maternal impression, like a belief in telegony, is a superstition with which no serious breeder will waste time; but it cannot be easily eradicated from the minds of the great mass of farmers, because it has sunk in so deeply."

A proposition which extremists sometimes class with the foregoing, but for which Dr. Wilsdorf shows more tolerance, is the belief in the inheritance of acquired characters. Stockmen, particularly in regions where breeding has been the occupation of the same family through many generations, have amassed rich stores of experience which satisfy them that animals under the influence of better care, feeding and housing change their form and characteristics, and that these changes occurring in the life of the individual are inherited by their progeny. This conclusion, which

[2]This is denied by C. B. Davenport, "Skin Color of Mulattoes," JOURNAL OF HEREDITY, V, 12, 555, December, 1914. The color seems to be due to numerous separate factors which act as units in inheritance. Dr. Wilsdorf might better have mentioned height as a character which shows blending; although in this case too the blending is very likely due merely to the fact that the unit characters involved are too many and too small to permit the observer to see their segregation. —The Editor.

found its first clear expression in the teachings of the zoölogist Lamarck and was in part at least accepted by Darwin, was strongly denied by the zoölogist Weissmann who is followed in this respect by most present day naturalists. The strife between adherents of Lamarckism and adherents of Weissmannism is bitter and continuous, and Dr. Wilsdorf does not think that, on the whole, it is very profitable to the science of animal breeding. Most of the alleged cases of inheritance of acquired characteristics he admits may be dismissed without much hesitation, but he sees others in which the influence of the environment seems to him to be transmitted directly to succeeding generations. "If we observe the well-known Arabian horse at home, we recognize in him a definite type, which is common to the whole breed in Arabia. The Arabs say of him, 'The Arab horse remains an Arab horse only so long as he breathes the air of the desert.' For centuries Arabian horses have been brought to all civilized countries and have astonishingly changed. The English Arab is different from the Hungarian, and both are different from the Prussian or Saxon or French. Whence comes this inherited variability in form, size, looks?

THE SIMMENTALER CATTLE.

"In the Bernese Oberland are the huge and beautifully formed cattle called Simmentaler. These, too, have been carried to all other countries, and at present there exist abroad a multitude of Simmentaler herds which in part, indeed, are similar, but in part show great differences. One more example: on the steppes of Hungary is found a breed of Steppe Cattle, of little value because of its low milk production. The increasing demand for milk has led the Magyars and the Hungarian government to seek in every possible way to increase the milk yield of this breed. High producing cattle from other districts have been brought in; sometimes these have been maintained and further bred pure; sometimes they have been crossed with the native cattle. At first, fine results were secured, but with further generations the newcomers became more and more like the old steppe cattle in form, size and milk yield, until finally the progeny of the North German and Swiss bulls and cows came to be almost exactly like the steppe cattle. Such cases, small or large, can be found in almost any cattle country in the world today."

In conclusion, the author warns his readers, let there be no misunderstanding as to what the science of genetics claims to have accomplished in Germany. Progress has been great —astonishingly great considering the short time involved—but the distance yet to go is still greater. "The question of the inheritance or non-inheritance of parental qualities, the problem of changing the inherited characters of animals during their youth, the maintenance of high fecundity joined to high production, the finding of tests of the fitness of animals for the purposes for which they are desired, the tendency to greater variability in many breeds, the prepotency of the different sexes, the determination of sex of progeny, artificial fecundation, the inheritance of diseases: all these questions and many others have either only been touched, or are wholly unexplored. As Dr. Müller of Tetschen, the founder of the German Genetic Association, aptly said, we stand before riddles,—but riddles whose solution we can attack with more hopeful zeal than ever at the present day; their solution will mean an immense gain to the live-stock breeder, the agriculturist, but perhaps no part of this gain will be greater than the light which will be thrown on the nature of Man himself."

DATE PALM ALLIES IN AMERICA

North American Fan Palms Related to the Genus Phoenix—Several Mexican Species With Date-Like Fruits—Majority of Palm Families Native to New World.

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THE finding of fossil date seeds in eastern Texas is an interesting discovery recently announced by Dr. E. W. Berry.[1] As date palms have been known hitherto only in the Old World, it may be worth while to call attention to the analogies presented by some of the native American fan-palms. The geographical obstacles to the recognition of such an alliance being removed by the discovery of the fossils, two questions naturally suggest themselves. Is the finding of these fossils to be taken as an indication that the date palm, or the genus Phoenix, originated in America, and which of the existing genera is to be looked upon as the nearest surviving relative of Phoenix in America?

It has long been recognized that Phoenix is much more closely related to the fan-palms than to other pinnate-leaved palms. Even the leaf structure shows that there is no alliance with the other pinnate palms, for in comparison with these the pinnae of Phoenix appear to be reversed, or up-side-down, being V-shaped in cross-section, whereas in all other pinnate palms the pinnae are Λ-shaped, as though folded down instead of up. This difference becomes very significant when we recognize the probability that the two forms of pinnae represent different methods of splitting an ancestral undivided, plicate or plaited leaf.

A plicate leaf split along the upper folds or ridges gives V-shaped segments. Splitting along the grooves between the ridges would result in reversed or Λ-shaped segments. These considerations are not altogether theoretical, in view of the fact that the seedlings of nearly all palms have undivided leaves. The mature, compound form of leaves is attained usually by very gradual stages of increasing the number of segments and splitting them apart. In all of the fan-palms that have deeply divided leaves the splitting takes place along the grooves, resulting in V-shaped segments, like those of the date palms.

Hence we may consider that the specialization of the date palm leaf consists mostly in the addition of an elongated rachis or midrib that allows the segments or pinnae to stand well apart, instead of being inserted on a central base, or ligule, like the radiating segments of the fan-palms. The leaves of some of the fan-palms show no indication of a midrib, as in the genus Thrinax and its relatives. But in most of the genera the middle segment of the leaf has a thickened midvein or rudimentary rachis. Some of the American palmetto palms present an intermediate type of leaf structure, with a more strongly developed midrib. The leaves of Inodes are of an oval form, and with a part of the segments inserted on a strong, decurved midrib, as shown in fig. 8. A further development of the midrib, sufficient to separate the segments, would afford a transition to a pinnate leaf, with a structure parallel to the leaves of the date palms. Hence we may say that as far as leaf structure is concerned the genus Inodes offers an analogy with the date palms.

PHOENIX AND PSEUDOPHOENIX.

As the name indicates, the genus Pseudophoenix also presents certain

[1] Fruits of a Date Palm in the Tertiary Deposits of Eastern Texas, American Journal of Science, 37: 403, 1914.

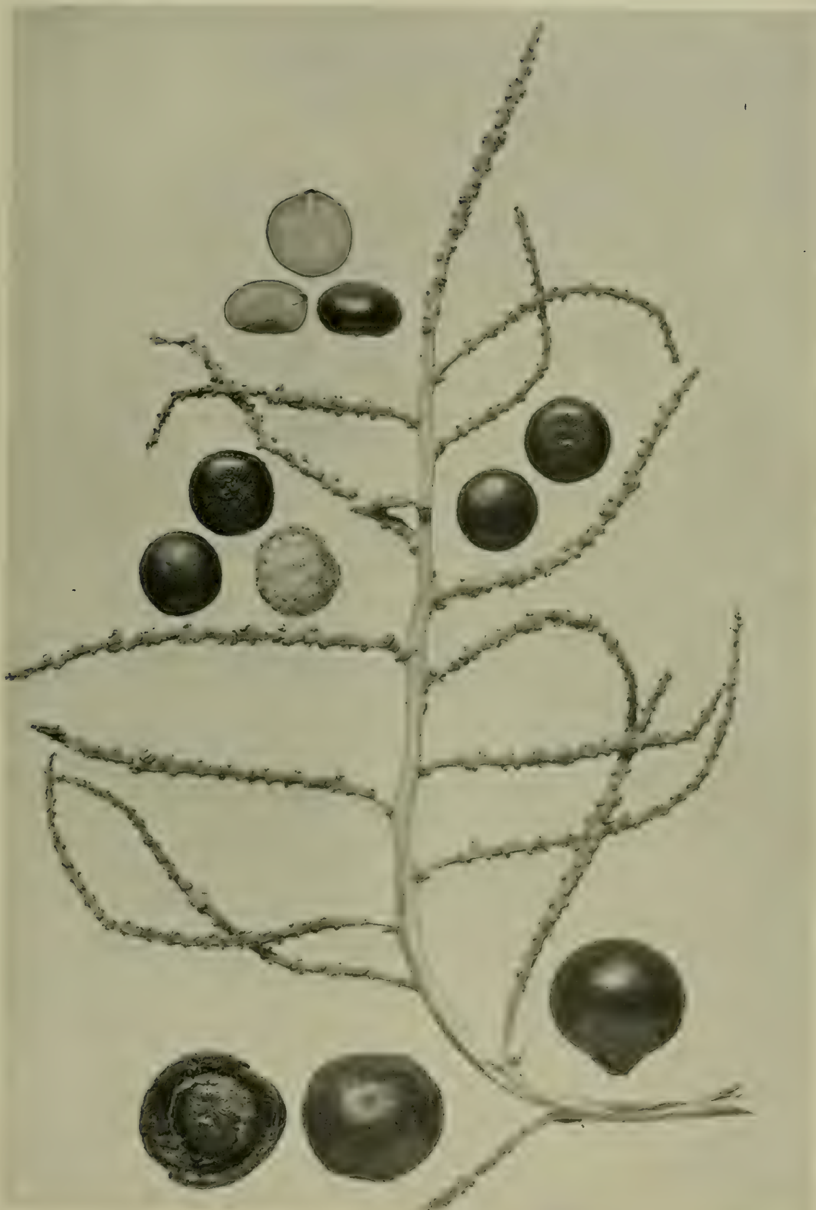
AN AMERICAN ALLY OF THE DATE PALM

If the date palm, which is now confined to the old World, really originated in America, as has recently been suggested, it ought still to have some relatives on this continent. This Mexican palmetto (Inodes) appears to be one of them. It will be noted that many of the segments of the leaves are inserted on a strong, decurved midrib. With a larger midrib or if the midrib were, so to speak, drawn out, the leaf would be elongated and would closely resemble that of the date palm. Photograph by G. N. Collins at San Pablo, Campeche, Mexico. (Fig. 8.)

analogies with the date palms. It is like Phoenix in being more nearly related to the fan-palms than to other pinnate-leaved palms, and may be considered as another independent offshoot from the fan-palms. With respect to the fruits there are distinct points of agreement with other American families of pinnate-leaved palms, more particularly with the coconut palms, ivory palms (Phytelephas), bag palms (Manicariaceae), and wax palms (Ceroxylaceae), but the leaves, inflorescences and flowers of Pseudophoenix are much closer to those of the fan-palms. The similarity to Phoenix lies in the fact that the pinnae are strongly plicate and are inserted very close together in irregular groups or clusters. Nevertheless, the resemblance is only superficial, for the folds or channels of the pinnae are below, as in the other pinnate-palms, instead of above as in Phoenix.

Thus although Pseudophoenix does not appear to have any direct alliance with Phoenix, it has a somewhat analogous relation to the American fan-palms, agreeing closely with them in some respects and diverging widely in others. The structure of the flowers is much like that of the fan-palms, each flower standing separately, on a distinct pedicel. The sexual specialization of the flowers is also very slight, scarcely more than in the fan-palms.

To admit the possibility of American origin for Phoenix would add one more family to the American palm flora, and would still further increase the already striking preponderance of family types in America. Though many botanists have classified the palms in a single family, the genera are numerous and fall into several very distinct groups that should be considered as families. Most of these groups are confined to America.



FRUIT AND SEEDS OF A MEXICAN PALMETTO

The fruit of this species, *Inodes exul*, probably approaches the date as nearly as that of any other palm now found on this continent. Such fruits are gathered in quantities by the Mexicans and form a staple article of diet in some districts. The seeds are surrounded by a layer of edible flesh about one-eighth of an inch thick. Photograph by C. B. Doyle, natural size. (Fig. 9.)

In presenting a summary of the families of palms in 1913, it appeared that 13 families are found on the American Continent and only 5 other families in the Eastern Hemisphere.[2]

If now the date palms are to be withdrawn from the Old World series and added to the New, we shall have the more reason to entertain the idea that this order of plant life had its origin and evolution somewhere on this side of the globe. It is also possible to distinguish a North American series of families from a South American series. To judge from the contrasts presented by the existing forms, North and South America have had separate palm floras for periods that must have been very long in comparison with the time that has elapsed since the continents were joined, for most of the palms that appear to have traveled along the Isthmus have occupied as yet only a small part of the regions that are now accessible to them.

FAN-PALMS WITH SEEDS LIKE DATES.

With these general considerations in mind we can better appreciate the interest of the fact that some of the American fan-palms have seeds rather closely similar to those of the date palm. This is most notably the case with the genus Brahea, where the seed is of the same general form and has a distinct longitudinal groove. The Florida saw-palmetto (*Serenoa serrulata*) also has fleshy date-like fruits, with seeds of the same general shape and external appearance, but lacking the longitudinal groove.

While the seeds described by Dr. Berry could not be referred to the genus Brahea on account of the position of the embryo and the depth of the longitudinal groove,[3] such differences are often found in closely related genera. Neither should too much weight be placed upon the elongate form of the seeds, which gives them so much similarity to the seeds of the familiar commercial varieties of dates. Some species of Phoenix have the fruits almost spherical, and this is true also of some of the varieties of *Phoenix dactylifera*.

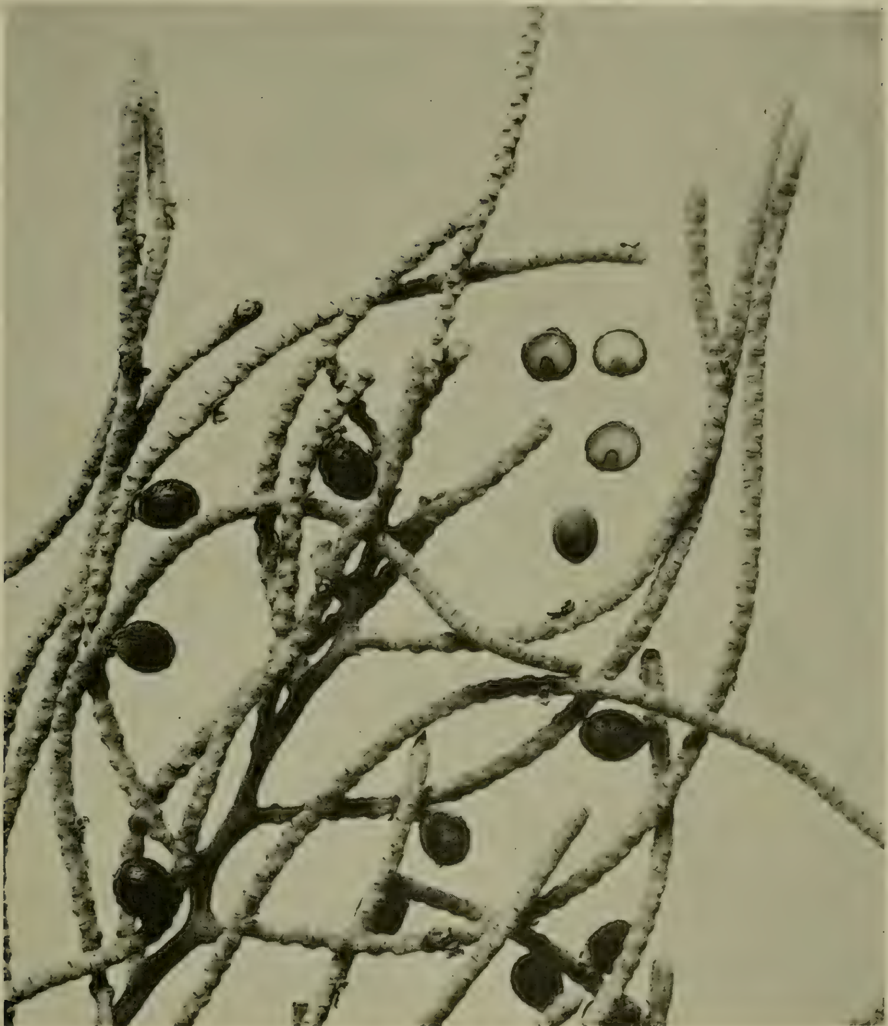
The similarity shown by the seeds of Brahea is at least sufficient to indicate that the form of the seeds is not a unique characteristic of the date palms, but a feature that may have been shared with older relatives now extinct. Unless the fossil remains are of a character to exclude such a possibility it will be easier to believe that the seeds found in Texas may represent some collateral relative of the date, perhaps even a fan-palm, rather than a true member of the genus Phoenix. Dr. Berry appears to have provided for this contingency by naming his fossils as *Phoenicites occidentalis*, instead of referring them to the genus Phoenix. Fossil palm leaves have been found in many localities in the western States, and even in Alaska. The fact that these were fan-palms need not be supposed to exclude the possibility that some of them may have borne date-like fruits, or that they may have spread as fan-palms to the Old World. The Polynesian fan-palms that have been described under the name Pritchardia and the Asiatic genus Livistona appear to have rather close relatives among the American fan-palms.

PRIMITIVE AMERICAN PALMS.

If the date palms originated in America or reached this continent at some later period it is difficult to understand why they should have become extinct, in view of the fact that some of the most primitive types of fan-palms have continued to exist in Florida, the West Indies and Central America. Moreover, a considerable number of the related American fan-palms, including such genera as Inodes, Brahea, Erythea and Washingtonia, live in open, desert regions, and have the same habits and ecological requirements as the date palms. The similarities extend to the production of fruits with fleshy, edible pericarps, not as thick or as sweet as those of the date palms, but neverthe-

[2] Cook, O. F., Relationships of the False Date Palm of the Florida Keys, with a Synoptical Key to the Families of American Palms. Contr. U. S. Nat. Herb., vol. 16, pt. 8, 1913.

[3] Drawings of the seeds found by Berry were published in the JOURNAL OF HEREDITY, V, 11, 499, Nov., 1914.



A MEXICAN RELATIVE OF THE DATE PALM

The belief that the date palm was an American species a million or more years ago is based on finding fossil seeds in Texas. This photograph of part of the inflorescence of a Mexican palm, *Brahea dulcis*, shows that some of the present American palms have seeds very much like those of a date, including the groove along one side, which is clearly shown in the cross sections of three seeds in the upper part of this plate. It is possible, therefore, that the seeds found in Texas were not those of the date palm, but of some ancestor of one of the present American genera like Brahea or Inodes. Photograph by C. B. Doyle, natural size. (Fig. 10.)

less used by the native Mexicans, and recognized by botanists in such names as *Brahea dulcis* and *Erythea edulis*. The fruits of *Inodes texana* or a closely allied species are eaten like dates and are an article of trade in the native markets in the Tampico district. The Indians of the Colorado desert in southern California think of the date palms that are now being planted by the white settlers as a superior kind of Washingtonia.

In one important respect the fruits of Inodes are the most like dates, for they have only a thin membranous endocarp while the other genera have a hardened

shell-like endocarp around the kernel, as may have been the case with the fossil seeds described by Dr. Berry, to judge from the following statement in the description of the fossil:

"The surface is longitudinally wrinkled, due possibly to desiccation before preservation, which may also make the dimensions as given probably under what they were in life. The flesh was relatively thin compared with that of the cultivated date and must have been of considerable consistency and fibrous rather than of the soft and almost fluid character of some of the modern varieties of the latter."

The very wide distribution of the species of Phoenix in the Eastern Hemisphere makes it the more difficult to credit a complete extinction of the group in the Western Hemisphere. Date palms are known from all of the tropical and subtropical regions of the Old World, from India through Africa to the Canary Islands, though they do not extend far into the Chinese region, to Australia, or to the islands of the Pacific. This is in contrast with the distribution of the Asiatic fan-palms, which are well represented in eastern Asia and the Pacific islands. With the possible exception of Raphia, no other genus of palms is so widely distributed as Phoenix, either in the Old World, or in the New. The only competitors in this respect are the palms that may have had human assistance, such as Cocos, Acrocomia, Attalea and Inodes. The last is the most ubiquitous in the wild state in the American tropics, and in this respect also may be considered as the American analogue of Phoenix. These two genera enjoy to a greater extent than most of their relatives the same adaptive advantage, that the seeds retain their vitality for long periods in the dry state. With most palms drying the seed soon kills the enbryo.

The relations of Phoenix with the Old World fan-palms might also have bearing upon the place of origin. Students of palms have generally agreed that Phoenix is most closely related with Chamaerops, a genus confined to the Mediterranean region, the Asiatic species formerly included in Chamaerops being assigned by recent authors to Trachycarpus. Chamaerops has larger and more date-like fruits than Trachycarpus, and stronger spines on the petioles. The production of hybrids between the date palm and Chamaerops has been claimed, but is difficult to credit in view of the numerous structural differences between the two palms. The date palm differs from all of the related fan-palms in having the sexes on separate plants, and in having the inflorescence highly specialized. The branches are mostly simple, and are arranged in clusters or whorls, a condition that may have been attained by uniting the basal joints of the primary branches with the main axis. Another profound difference is the reduction of the spathes to a single one, which encloses the entire inflorescence until the time of flowering.

If the fossil seeds from Texas represent a true date palm, it may be expected that remains of other Asiatic genera of fan-palms will be found in America. On the other hand, if the fossils represent a collateral relative of the date palm the separation between Phoenix and the Old World fan-palms may have occurred in the Eastern Hemisphere. In view of the analogy presented by Brahea, the former presence of Phoenix in America can hardly be determined from the seeds alone. Other parts of the plant are needed to make the identification secure. It is to be hoped that nothing in the way of palm materials will be overlooked by those who have the opportunity to collect fossil plants in the Southwestern States.

WHEAT BREEDING

Many Genetists Working With Important Cereal Crop—What They Have Accomplished—Hope for Future Improvement—Methods of Procedure.[1]

A. E. V. Richardson

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SYSTEMATIC breeding of wheat and other cereals has been practised for many years past in the United States, Canada, Germany, France, Sweden, Britain, and India.

A large number of agricultural experiment stations and colleges in the United States are at present engaged in breeding new varieties of wheat. The Minnesota station has originated numerous varieties, two of which have "yielded from 1 to 3 bushels more per acre than the varieties formerly grown."[2] Other stations, particularly Maryland, North Dakota, California, and Ohio, have done much valuable work in the production of new varieties and the improvement of existing types.

In Canada most of the breeding and selecting of wheat has been done in connection with the Dominion Experiment Farm system on the central station at Ottawa. The late William Saunders began the work of wheat improvement in Canada in 1888. Working on the Red Fife wheats, he succeeded in producing the cross-bred varieties Stanley, Preston, Huron, Marquis, and Bishop, which are now widely grown throughout Canada.

In England, Biffen of Cambridge has done a large amount of work in wheat improvement, paying special attention to the production of a variety of wheat combining the important qualities of (*a*) high yielding capacity of the English varieties; (*b*) the high strength characteristic of the Manitoba wheats; and (*c*) immunity from yellow rust (*Puccinia glumarum*). He claims to have achieved considerable success in this direction.

In Sweden, the wheat breeding is concentrated at Svalöf under the direction of the Swedish Grain Society. This society has done a vast amount of good in introducing superior varieties of wheat in Swedish agriculture. No less than fifteen trained plant specialists are engaged in this work. Details of this institution will be discussed later.

In Germany, a large number of public and private institutions are engaged in the improvement of cereals and root crops. According to Hillman,[3] there are no less than 84 breeders engaged on the improvement of wheat, 46 of rye, 65 of barley, 53 of oats and 44 of fodder and sugar-beets.

A considerable amount of work has been done in India towards the improvement of local wheats by selection and crossing.

WHEAT BREEDING IN AUSTRALIA.

The outstanding feature in wheat-breeding work in Australia is the remarkable success achieved by that patient and retiring genius, the late William Farrer, of New South Wales, in every branch of wheat improvement.

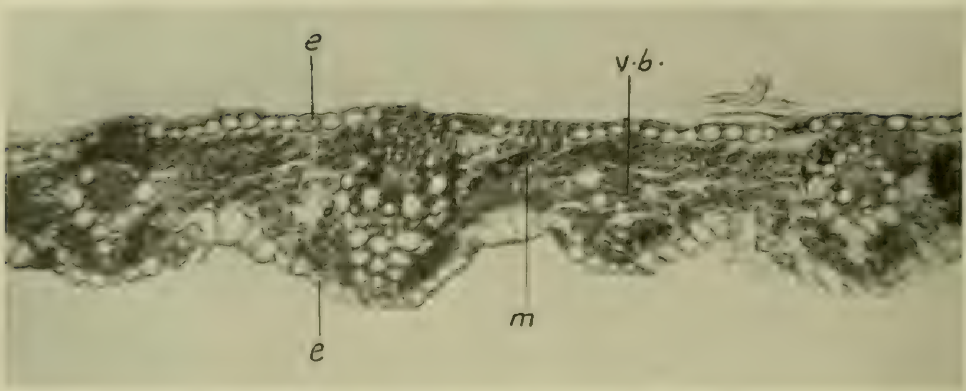
A man who could set out as clearly and comprehensively as Farrer,[4] both the goal toward which he was striving in his work of wheat improvement, and the methods whereby he hoped to

[1] Parts of a paper read before the Australasian Association for the Advancement of Science, January, 1913; published in altered form in Bul. 22, n. s., Victoria Department of Agriculture.

[2] Year-book of the U. S. Department of Agriculture 1908, p. 155.

[3] P. Hillman, Arb. Deut. Landw. Gesell. (1910) No. 168.

[4] Farrer: The making and improvement of new varieties of wheat for Australian conditions. *Agricultural Gazette* (N.S.W.), February, 1898.



CROSS SECTION OF A WHEAT LEAF

Above and below, the leaf is bounded by a single layer of epidermal cells (*e*), between which lies the main mass of the leaf cells, the mesophyll. "The upper portion of the mesophyll is typically closer in structure than the lower portion, which is usually spongy in character and contains a large number of intercellular spaces. These intercellular chambers form labyrinthine spaces in which air circulates freely in the interior of the leaf. Scattered through the body of the mesophyll are the vascular bundles (*v.b.*) which form in wheat a set of parallel strands serving not only as skeleton for the support of the remaining leaf tissues, but also as media for the conduction of sap to every part of the leaf." Photograph highly enlarged. (Fig. 11.)

reach that goal, and in less than a decade flood the market with varieties like Federation—the most prolific and popular farmer's wheat in the Commonwealth; Bobs and Comeback—of unsurpassed milling excellence; Florence and Genoa—bunt-resisting varieties; and a host of others enjoying widespread popularity, such as Bunyip, Thew, Bayah, Warren, Genoa, Firbank, Cleveland, Cedar, Jonathan, etc., must have possessed in an unusual degree the insight of genius. It is no exaggeration to say that Farrer has added millions sterling to the national exchequer by the creation of Federation wheat. Dr. Cherry estimates the cash value of Farrer's work to Victoria alone during the 1909 season at £250,000. Since that estimate was framed, the area sown with this popular variety in Victoria has greatly increased, and the benefits have become commensurately greater.

Farrer's work was continued by G. L. Sutton, late Wheat Experimentalist of New South Wales, who did a great deal to popularize the Farrer varieties amongst farmers.

In this State, H. Pye, the present Principal of Dookie Agricultural College, has been the most prominent investigator of the problems connected with the improvement of wheat varieties. For many years he collaborated with Farrer in the testing of new varieties, and the independent work he has done has resulted in the production of a number of crosses possessing improved qualities, which are now undergoing the process of fixing and testing on a commercial scale. The work of producing new varieties of value is necessarily slow and tedious, and the results of Mr. Pye's long and patient work will doubtless be of immense benefit to wheat-growers.

In South Australia, the improvement of varieties by selection and cross-breeding is carried out at the Parafield Wheat Research Station and at the Roseworthy College. The demand for improved and selected cereals from both these centers has for many years past greatly exceeded the supply.

Many of the varieties grown in the wheat areas of the Commonwealth were originated by private farmers. With one or two exceptions, these varieties were obtained by selection from the ordinary crop. Among many of the varieties that might be mentioned are Dart's Imperial, Marshall's No. 3, Correll's No. 7, King's Early, Yandilla King, Steinwedel, Petatz Surprise, Carmichael's Eclipse, and Huguenot. In

most cases these varieties originated from a single plant growing in the ordinary field crop. The outstanding qualities of these plants arrested the attention of the originator, who harvested them separately, and multiplied the seed for distribution.

OBTAINING IMPROVED VARIETIES.

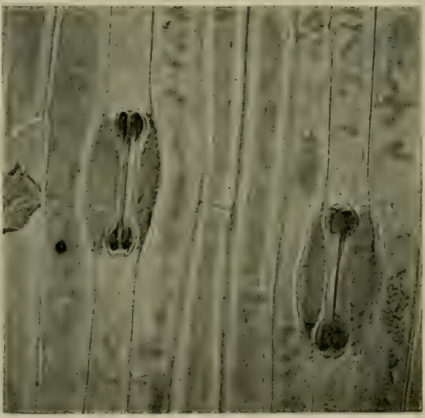
There are two general methods by which improved and new varieties may be obtained, namely, by—

1. Selection.
2. Cross-breeding.

We will consider each of these in some detail.

Vilmorin, a renowned authority on plant breeding, states that "selection is the surest and most powerful instrument man possesses for the modification of living organisms." Reduced to simplest terms, it consists merely in the choice of the best individuals for the propagation of seed, and it is by means of selection exercised through centuries that our cultivated plants have reached their present standard of excellence. The obvious effects of selection may perhaps be seen to best advantage in the animal world. It was by patient, systematic selection, exercised over a long period of years, that the famous Booth and Bates types of Shorthorn cattle were developed. What we term pedigreed stock in Merinos, Clydesdales, Jerseys, etc., have been produced by a slow, painstaking process of selecting the very best animals in the herd, accompanied by a vigorous exclusion of the culls. While the vast majority of farmers are well aware of the beneficent effects of selection in the animal world, they appear to be totally oblivious of the fact that selection can be equally effective when applied to the plant world.

The term "selection," as commonly used, covers a general, as well as a specific, idea. In its general sense, selection is practiced by every good farmer when he chooses varieties of wheat that are best suited to his soil and climatic conditions, reserves the best portion of his crop for seed purposes, and takes good care to grade his seed well. No well-informed stock breeder would think of selecting as his parent stock



HOW A LEAF BREATHES

Above, epidermis of Federation wheat (under surface of leaf), showing the stomata or breathing pores. "Each stoma or pore consists of two sausage-shaped guard cells joined together at the extremities in such a manner as to leave a very narrow slit-like pore between them." The stomata open and close in accordance with the respiratory needs of the leaf, this movement being brought about by changes in the curvature of the guard-cells, which in turn depend on the turgidity or water content of the · ells. Below, the same further enlarged (to about 300 diameters). (Fig. 12).

any other than the best animals he can secure with the means at his disposal. Nor should any wheat farmer be satisfied with anything but the best of his crop for seed purposes. He should take the greatest pains to get, first, the right variety of wheat; second, well-developed seed; and third, the seed should be secured from the most vigorous plants. The latter point is very important.

WHAT THEY ARE WORTH.

With regard to the choice of varieties, it may be pointed out that the difference in yield between two varieties of wheat grown on the same farm, under precisely similar soil and climatic conditions, is frequently sufficient to pay the rent and interest on the land on which the crop was grown. This has been demonstrated time and again in departmental experimental plots and on private farms.

Carefully-conducted experiments in various parts of the world demonstrate that it pays a farmer to give careful attention to the selection of his seed.

In Canada, Zavitz[5] states that during twelve years' work at the Ontario Agricultural College, large, well-developed grain of winter varieties of wheat averaged 46.9 bushels per acre, as against 39.1 bushels from small shrunken seed, and with spring wheat the average yield from the well-developed, plump seed was 21.7 bushels, as against 16.7 of the small seed.

In Britain, the University College of Wales[6] reports that nearly double the yield was obtained from plump grain as against small grain.

Desprez, in France,[7] after experimenting with a large number of varieties of wheat, draws the conclusion that the results are markedly in favor of large seed.

Cobb (N. S. W.),[8] after an exhaustive comparison of seed wheat from 24 varieties, states that the increased yield obtained from well-graded seed is sufficient to justify the installation of first class cleaning machinery.

The results obtained at some of the American Experiment Stations are conflicting, but, wherever care was taken in the selection of seed, considerable increases in yield resulted. This was the case at Kansas, Nebraska, North Dakota, and Indiana experiment stations, whilst at Pennsylvania and Ohio no marked increases resulted.

From these various experiments it may be safely concluded that the best results will be obtained by the selection of well-developed, plump seed, from plants of strong vitality.

The term selection is generally more restricted in meaning. It has now acquired a technical significance, and implies the systematic choosing of specific wheat-plants for future reproduction, with the object of bringing about an amelioration of type. It recognizes that there are endless variations of type in an ordinary wheat crop—that there are grades of quality in wheat just as there are grades of quality in fruit and butter.

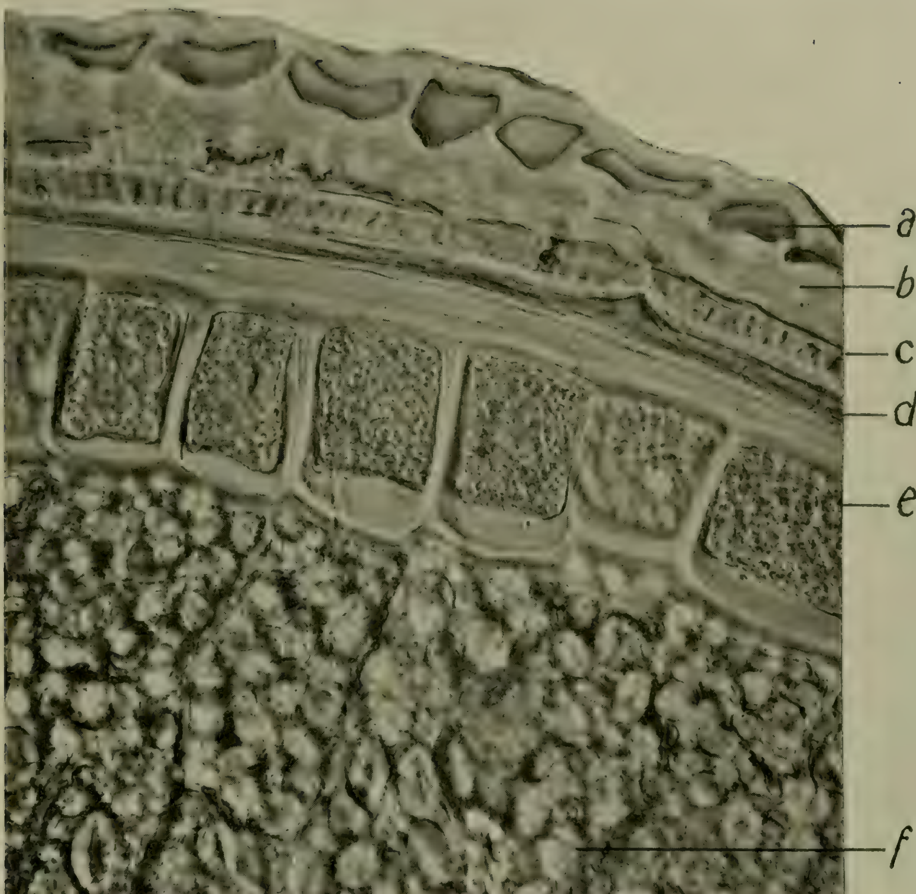
Selection seeks to isolate those types of plant which approximate most nearly to the ideal, and systematically to choose from the produce of these types the variations which are likely to be of material value.

This is the manner in which most of the improvements in our field crops have occurred.

TWO KINDS OF SELECTION.

Of course, many of the modifications effected in plants, through long years of cultivation, are the result of unconscious improvement. This is exemplified by the development of the cabbage, cauliflower, and kohl-rabi from the woody perennial plant *Brassica oleracea*, which is a native of Southern Europe. The cabbage is a modification of the leaf, the cauliflower of the inflorescence, and kohl-rabi of the stem of this plant, and their origin is due to long-continued selection of variations which were considered desirable, and not because the gardener consciously

[5] Zavitz: *Journal of the Board of Agriculture*, June, 1910, p. 35.
[6] Report of University College of Wales, 1899, p. 68–70.
[7] Jour. Agri. Prat. (1897).
[8] Cobb: *Agricultural Gazette*, New South Wales, 1903.



A GRAIN OF "FEDERATION" WHEAT

Transverse section, enlarged about 400 times. The structures shown are as follows:

(*a*) The *epidermis*, which consists of a layer of longitudinal cells with their long axes in the direction of the length of the kernel.

(*b*) Second layer, the *epicarp*, very similar to the former in general appearance resting on an irregular layer apparently devoid of cellular structure.

(*c*) The *endocarp*, placed at right angles to the cells above described. In cross section the cells of the endocarp appear to be very regular in character, with thick cell walls which in longitudinal section display minute pits.

(*d*) The *testa*, consisting in the unripe kernel of two distinct layers of cells closely applied to the aleurone layer. The testa is very tough in charater, not readily permeable to water and homogeneous in structure.

(*e*) The *aleurone* layer, consisting of large more or less rectangular cells, with thick cell walls containing oil and granular nitrogenous matter. It is frequently called the gluten layer, though this is a misnomer, as the gluten found in the flour is derived from the starch cells of the endosperm and not from the aleurone layer.

These five layers constitute the *bran*, and are usually removed when the wheat is milled. Beneath them are (f) the starch granules, which are ground up to make white flour. (Fig. 13.)

attempted to evolve these specific forms.

On the other hand, many instances might be quoted in which improvement has been effected by systematic breeding.

Perhaps the most striking case is that illustrated by the development of the sugar content in beets. By a process of careful, repreated, and systematic selection of individual plants of high sugar content, combined with the repeated testing of the hereditary powers of each individual plant, the common beet, containing from 6 to 7% of sugar, has been developed into the sugar beet, containing from 20 to 25% of sugar.

The value of this improvement must be obvious. It has enabled the beet-sugar industry in Europe and America to more than hold its own against the cane sugar produced by black labor in the Tropics.

A remarkable case of selection is referred to in De Vries'[9] work. In 1886, De Vries found at Loosdrecht a plant of clover bearing a few leaves with four and five leaflets. He commenced some experiments to fix this type of clover. By continuous cultivation and selection, he ultimately (1892) secured plants in which four and five leaflets on each leaf were common, and, strangely enough, for the first time several leaves appeared with six and seven leaflets.

It is very probable that no clover plant in the world ever possessed six or seven leaflets until De Vries commenced these experiments.

HISTORY OF WHEAT SELECTION.

The idea of improving cereals by selection is of comparatively recent origin. The most notable of the early wheat-breeders were Le Couteur, of Jersey; Shireff, of Haddington; and Hallet, of Brighton.

Le Couteur, nearly a century ago, observed that an ordinary field of wheat appeared to be extremely variable, and concluded that some of the various types found in the growing crop would yield better than others. He isolated 23 distinct types, and grew them separately, and was successful in introducing several new varieties into general cultivation. One of these is still grown under the name of Talavera.

A Scottish agriculturist—Patrick Shireff—developed the celebrated Hopetown oats in 1832, and placed on the market four distinct varieties of wheat, all of which were extensively grown in his time. His method of procedure was to walk through his wheat fields at harvest-time, and mark any plants which stood out prominently from the surrounding plants. He isolated these plants, sowed them separately, subjected them to severe tests, and sold the seed of the most promising types.

It is very interesting to note that neither of these breeders adopted the principle of *repeated* selection. They simply isolated individual plants of promising appearance, and multiplied the seed of these types as rapidly as possible. There was but one initial selection, followed by rapid multiplication of the progeny. On this fundamental point they differed widely from Major Hallet, who began his work of selection in 1857. His method of selection was derived from his previous experience of breeding Shorthorn cattle.

He first introduced the principle of repeated selection. His method was to select each year the best grain from the best ear of the best plant he could find in his wheat-field, and to repeat this process for a number of generations On 18th June, 1862, he inserted a full-page advertisement in the *Times*, describing his methods of breeding wheats. In this advertisement he states that his "pedigree wheat was bred upon the same principle of *repeated* selection which has produced our pure races of animals."

During his first five years' work, the length of the head was doubled, the number of grains in the head trebled, and the tillering capacity was increased fivefold.

The improvements effected were, in a measure, artificial, inasmuch as he grew his selected plants on the very best and richest garden soil. Nevertheless, his strains were a success, and greatly improved the harvests of his generation.

[9] De Vries: "The Mutation Theory," Vol. II., p. 36 (1910).

FLOWER OF WHEAT, MUCH ENLARGED

The ovary (*o*) contains the minute ovule or egg cell which, when fertilized by a pollen grain, will develop into a grain of wheat. From the ovule arise the feathery styles (s), whose function is to catch the pollen grain and give it access to the ovary. The stamens (*st*) are three in number, each one consisting of a slender stalk—the filament—bearing at its summit the anther or pollen sacs, which in this case consist of four longitudinal chambers containing large numbers of pollen grains (sperm cells). Normally these pollen-grains fall directly on the styles below, so the wheat flower is self-fertilized; but to serve his own purpose the breeder removes these anthers, and introduces pollen from some foreign source, thus ensuring cross fertilization. (Fig. 14.)

The same principle of repeated selection has since been very largely practised in Germany, and has been very successful. Rimpau, in particular, has applied this principle of gradual improvement by continuous selection to rye, and succeeded in developing the famous Schlanstedt rye, which is now grown throughout France and Germany.

THE SVALÖF METHOD.

Finally, it is necessary to consider briefly the method of selection adopted at the famous Swedish Experiment Station at Svalöf, Sweden. It may be explained[10] that this station owes its origin to a small coöperative village company, formed in 1886 by private farmers for the production of improved seed wheat, oats, and barley, and the testing of new and foreign varieties of grain.

R. B. Greig,[11] one of the members of the Scotch Commission who visited Australia in 1911, gives a most interesting account of a visit to this remarkable institution. He says: "The work at Svalöf is based on two discoveries—first that among the farm crops there exist an indefinite number of elementary species which breed true; and secondly, that superior individuals among these species can be quickly recognized by certain morphological characters. The first discovery was almost an accident; the second was the result of painstaking and minute investigation, assisted by an elaborate system of record keeping.

[10] For a fuller account see Plant Breeding in Sweden by H. Hjalmar Nilsson. JOURNAL OF HEREDITY, V, 7, 281, July, 1914.

[11] Vide *Journal*, Board of Agriculture, London, August, 1910, p. 280.

"By a comprehensive series of trials, the principle was firmly established that the proper unit of selection is the single ear or head. Further investigation brought out the fact that in an ordinary field of oats, wheat, or barley there were dozens of different types, most of which bred true. The next step was to discover the superior types, or those specially adapted for special conditions. It has been demonstrated that certain characters of apparently negligible importance are actually trustworthy indicators of the productive power of an individual and of its quality. This principle of correlation or association of characters has been found applicable to all farm crops, and while it sheds a brilliant light to guide the improvement of crops, and provides a short cut to success, it effectively bars any but the trained specialist from the speedy recognition of new varieties by selection."

There are two general methods of selection adopted by plant-breeders—*mass* selection and *individual* selection.

Mass selection consists of the continuous and repeated selection of a number of the best grains, ears, or plants. It is based on Darwin's conception of the origin of species, and it is supposed that by the repeated selection of a number of élite plants each year, the race, as a whole, will be gradually improved.

De Vries denies that any permanent improvement can result from mass selection.

Fruwirth, on the other hand, affirms that mass selection does result in permanent improvement.

The effect of mass selection, as applied to oats, barley, and potatoes, has been strikingly demonstrated by Professor Zavitz at Ontario.[12] The following table summarizes the results of sixteen years' continuous mass selection on these crops:—

AVERAGE YIELD IN FOUR YEAR PERIODS IN BUSHELS PER ACRE OF OATS, BARLEY, AND POTATOES, SHOWING THE EFFECT OF MASS SELECTION ON SELF-FERTILIZED AND ON VEGETATIVELY PRODUCED CROPS:—

Crops.	1890–93.	1894–97.	1898–1901.	1901–05.
	Bushels	Bushels	Bushels	Bushels
1. Oats—Average for 8 varieties........	74	79	83	100
2. Barley—Average for 8 varieties......	50	54	63	63
3. Potatoes—Average for 8 varieties....	120	216	218	249

Mass selection is most effective when the individual plant is made the unit of selection, and not the individual ear or the individual grain, for it frequently happens that large grains and large ears of wheat are found on relatively poor plants.

Mass selection thus practised tends towards improvement of the type by propagating from the best plants and excluding all the rest. It may, of course, happen that some of the selections thus made are superior because they have been grown under favorable environment. They may, for example, have received an extra amount of superphosphate through the irregular working of the drill, or they may have been favored with more space to develop than the majority of plants in the crop. However, the repeated and rigorous selection of the best plants would gradually confine the choice to what might be termed the permanently superior plants, and the general character of the crop would gradually improve in the desired direction.

Mass selection has been practiced with great success at the German experiment stations, and by such breeders as Rimpau, Drechsler, and Mokry. There are several different ways in which this method of selection may be applied. Whatever method is adopted must

[12] Report, Ontario Agricultural College, 1905.

obviously involve as little labor as possible, and take up a minimum of time. To be completely effective, the selection must be continuous and uninterrupted, *i. e.*, the selection must be kept up year after year to counteract any tendency on the part of the wheat to degenerate.

A method which has the merit of being continuous and of requiring a small amount of labor is the following:—

A field of the variety which it is desired to improve by mass selection is carefully inspected at harvest-time, and sufficient of the best-developed heads from robust, well-developed, prolific plants is selected to yield, on hand-threshing, about five pounds of graded grain. This seed may be sown at seed-time, say in 1915, in one strip of the drill, on approximately one-tenth of an acre, as a "stud" plot. At harvest-time a similar process of selection of the best heads from the strongest plants in the "stud" plot is carried out, and the produce of the selection is reserved to form the "stud" plot of 1916. The balance of the "stud" plot of 1915 is harvested and sown as the "seed" plot of 1916 on an area of approximately two acres. In 1916 the process is repeated. The best selected heads of the 1916 stud plot become the stud plot for 1917, and the balance of the stud plot becomes the "seed" plot of 1917. The 1916 seed plot of two acres is harvested and sown on, say, 30 to 40 acres as a "bulk" plot for 1917, from which seed for the whole farm is obtained. Thus, after three years, the selection becomes automatic. The small stud plot has been selected for three years, and represents the "élite" plants of a race which is gradually approaching a pedigreed character.

The full effects of the process would not be felt for at least three years—the time taken for the "stud" plot to become the "bulk" plot.

INDIVIDUAL SELECTION.

The method could be made more systematic by making the unit plot a single row of specially-selected plants, and rigorously selecting each season the very best plants of each row.

WHEAT ANTHER

It is made up of four pollen-sacs, which are about ready to burst at the lower ends, releasing the translucent pollen grains that are visible inside, and letting them fall on the stigma below. (Fig. 15.)

When the individual plant or ear is made the starting point, we have what is known as individual selection. In this case the selection commences with a number of superior plants of a given variety, and the seeds from each plant or ear are separately planted, and kept under continual observation. This enables a strict comparison to be made of the progeny of each selection, so that in a few years the best strain in the original selections may be determined and multiplied for future use.

Nilsson, at Svalöf, after subjecting the older methods of mass selection to a critical examination, decided to adopt the method of single-plant selection used by Shireff and Le Couteur, and has achieved a considerable amount of success. The method of procedure has already been described. As a principle, it is based on De Vries' conception of the origin of species, and it assumes that repeated selection is unnecessary.

Another example of individual selection is afforded by the method introduced by Willet M. Hays, founder of the American Genetic Association. His method consists in isolating the most promising types of plants in a crop, and of testing the efficiency of the selection by comparing the prolificacy of the 100 plants derived from each of the strains so isolated.

For this purpose the produce from individual plants are sown in "centgener" plots. One hundred and forty-four seeds of each selection are sown in a square, with 12 seeds along each side. At harvest-time the outside border row is removed, and the remaining 100 plants are harvested, and the total produce obtained is taken as a measure of the prolificacy of a given strain.

Hays made a close study of variation in wheat, and found that those characters such as yield, which can be expressed in numbers, follow what is known as Quetelet's Law of Variability.

A simple illustration of Quetelet's law may be obtained by comparing the measurement of the height of 1,000 men of the same nationality. If 1,000 men be selected at random and arranged in a row in order of height, it will be found—

(*a*) the man in the middle of the line represents the average height of all men;

(*b*) a line drawn over their heads will diverge only very slightly from the horizontal throughout its entire length, falling gradually towards the end where the smaller men are placed;

(*c*) the line will rapidly curve upward near the upper end of the line where the tall men are placed, and will curve rapidly downward at the lower end where the shorter men are standing.

Hays[13] points out that if the individual yields of a large number of wheat plants of any given variety are arranged in order, a precisely similar curve may be obtained to that illustrated above. The great majority of the plants give only an average yield, a few give a very poor yield, and a few give an exceedingly high yield.

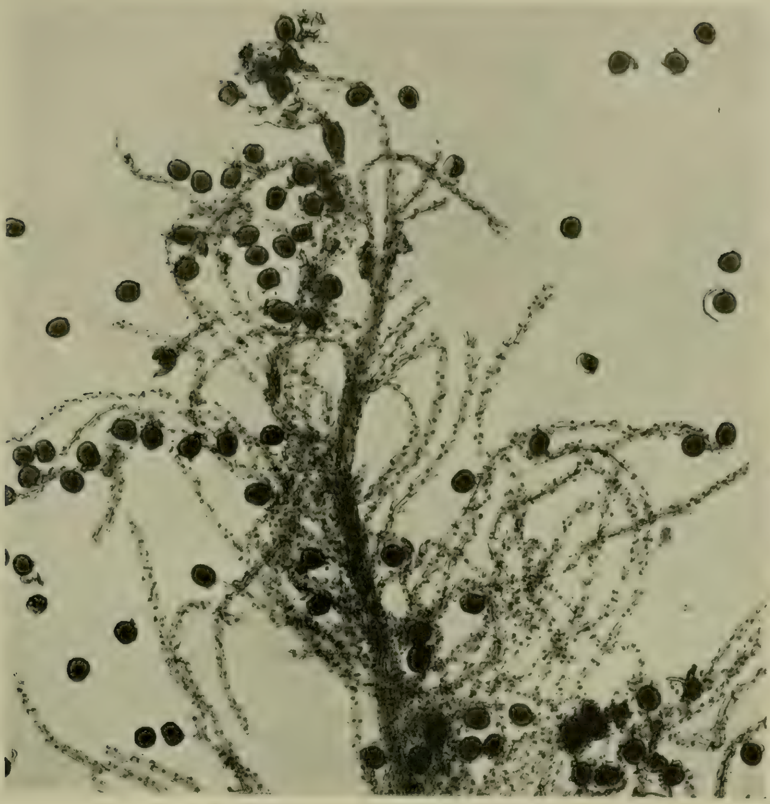
These latter are the plants which he uses for his future selections.

Hays states that in "each 1,000 plants of wheat there are a few phenomenal yielders, and the method of single seed planting makes it practicable to secure these exceptional plants, and from these new varieties can be made."

HAYS' PRODUCTION.

Working on Fife and Bluestem varieties of wheat, which were largely grown in Minnesota, he succeeded in producing improved strains which gave yields of 15-20% more than the original types, and which have largely displaced them from general cultivation. Thus Minnesota 169 wheat was bred by a process of selection from a Bluestem variety commonly grown in Minnesota. During four consecutive years it averaged in field trials 4.9 bushels more than the parent type. In 1902 it was distributed in four-bushel lots to 375 farmers, and reports showed that its average yield in 1903 was 21.5 bushels, as compared with 18.2 bushels average for the common varieties, *i. e.*, an increase of 3.3 bushels, or 18%. Hays judges the efficacy of a given selection, not by

[13] Bulletin 62, Minnesota Experiment Station, U. S. A.



STIGMA OF WHEAT FLOWER

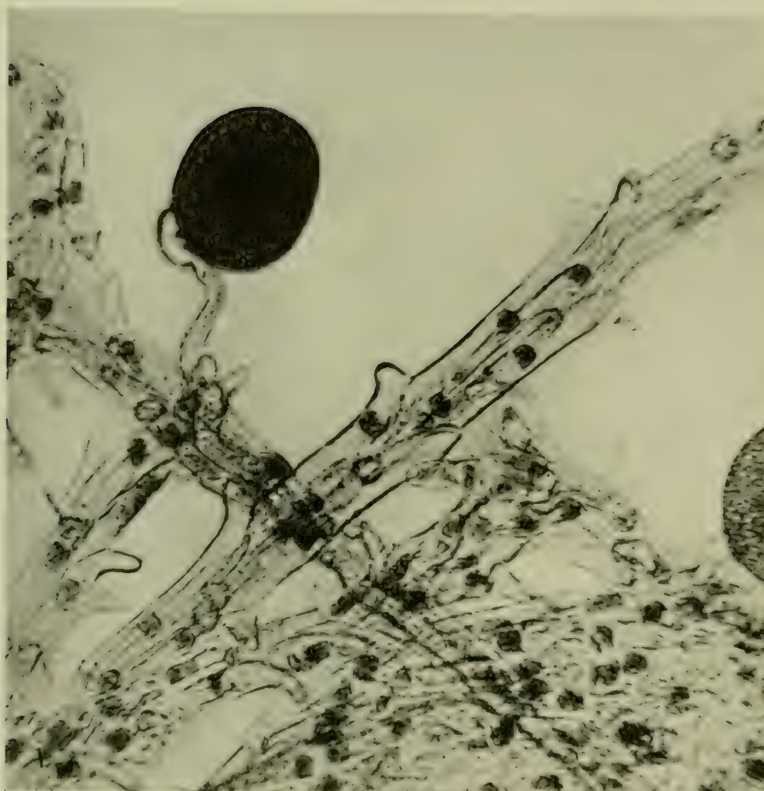
Portion of the style, highly enlarged. Numerous pollen grains have already fallen on it and can be seen adhering to it; in several cases they can be seen putting forth pollen tubes. These penetrate the stigma and grow down into the ovary; one of them finally comes in contact with the ovule, and fertilization ensues. (Fig. 16.)

qualitative differences, but by the quantitative factor—namely, the average yield of the progeny of each individual selection. This principle gives a far more satisfactory basis for work than the judging of a plant by its mere external characteristics, more especially when the end sought is an increase in prolificacy of a given variety rather than an improvement in some specific quality, such as milling excellence or rust resistance. It is therefore of great practical importance for those who are desirous of effecting improvements in prolificacy of our standard varieties of wheat.

Of course, in attempting an improvement in a given strain of wheat by any of the methods described above, care must be taken to avoid choosing those plants which excel their neighbors through merely accidentally favorable circumstances.

Irregular distributions of manure, variations in quality of the soil, and irregular seeding obviously lead to irregularities in the appearance of the individual plants, and considerable judgment is required on the part of the operator to decide whether the outstanding plants in a given crop really excel on account of individual excellencies or because they have been specially and accidentally favored in the struggle for existence.

The second method of effecting specific improvements in plants is by means of cross-breeding or hybridization.



HOW FERTILIZATION IS ACCOMPLISHED

This pollen grain has fallen on the stigma and put forth a slender tube which will grow down one of the branches of the stigma to the style, through which it will continue to grow until it reaches the ovule. Here, if favored by chance, it will come in contact with the minute ovule or egg cell. The nucleus of the pollen grain (the sperm cell), which has been gradually slipping down the tube, will then enter the ovule, unite with the nucleus of the ovule, and set in motion the machinery of cell division which will finally result in the development of a grain of wheat. (Fig. 17).

In effecting improvements by cross-breeding the mode of procedure is to cross two varieties of wheat possessing divergent and complementary characteristics, and selecting from the widely varying progeny those particular individuals which possess in the highest degree the specific qualities which we are seeking.

In order to apply such a method effectually it is necessary to have a clear conception of the goal towards which improvement is to be wrought, a knowledge of the unit characters of the different varieties, and of the laws governing the inheritance of these unit characters.

The act of crossing, and the actual production of merely new varieties is simplicity itself—the fixing and production of *valuable* varieties is extremely difficult.

Before discussing the method of crossing wheats, let us consider briefly the structure of a flower of wheat. The "head" or "ear" of wheat is known in botanical language as a spike, and consists of a flattened stem or rachis bearing alternately a series of structures known as "spikelets." Each "spikelet" or "chest" consists of several flowers. Usually each spikelet of most varieties has three to five flowers, from each of

which a grain of wheat may develop. The flower itself consists of two parts—

(*a*) the protective parts, consisting of glumes and pales.

(*b*) the essential parts—the stamens and pistil—*i. e.*, male and female organs. (Fig. 1.)

We are concerned here especially with the essential organs. The stamens (St.) are three in number, and represent the male organs. Each stamen consists of a slender stalk—the filament, bearing at its summit the anther or pollen sacs, which in the case of the wheat plant consists of four longitudinal chambers containing large numbers of minute pollen grains (sperm cells).

The female portion of the flower—the pistil—consists of the ovary with a minute ovule (or egg cell). The upper part of the ovary bifurcates and forms two long, slender, feathery structures—the styles. (Fig. 14.)

The pollen grain falls on the stigma of the flower and "germinates," sending a slender tube through the style until it reaches the ovule when the pollen nucleus slips down the tube to join the ovule nucleus, and fusion and fertilization take place.

How the crossing is done.—In the case of the wheat plant the flowers are normally self-fertilized. Natural cross fertilization is very rare. Moreover the flowers are hermaphrodite, *i. e.*, male and female elements are borne on the same flower. The wheat plant is said to be in "flower" when the anthers begin to extrude from the glumes. With wheat, however, fertilization takes place before "flowering." In order to cross one variety with another it is necessary that the pollen of one variety should be dusted on the ripe stigma or female part of the second variety. The plant from which the pollen is taken is generally described as the male parent, whilst the plant on which the crossing is done is referred to as the female parent. I find the following method gives satisfaction. A well developed "ear" of the "female parent" is chosen and prepared in the following manner:—

The basal spikelets amounting to approximately one-third of the ear are stripped off, and the top third of the head removed with a pair of scissors. Four or five spikelets are thus left on each side of the center of the ear. These spikelets invariably contain three to five flowers. All flowers save the outside pair are removed with a pair of forceps. Thus the ear is reduced to 12 to 20 flowers (Fig. 18). It is now necessary to "castrate" the flowers by removing the three anthers from each. The point of the forceps is gently inserted between the upper margins of the inner and outer pales, and, by releasing the pressure on the forceps the flower is gently forced open, exposing the three anthers and the feathery stigma. With a little practice these anthers may be removed unbroken with one stroke of the forceps. It is, of course, necessary to prepare the ear in this fashion before any of the anthers have shed their pollen grains. The best stage at which to carry out the operation is when the anthers are just approaching maturity and turning yellow in color. Having castrated the whole of the flowers by the removal of all traces of the anthers, the ears may be wrapped in cotton wool until the stigmas of the flower become "receptive" or ready to receive the pollen. The cotton wool may then be removed, and ripe anthers of the particular variety desired as the male parent should then be secured. The anthers should be quite "ripe," *i. e.*, bright yellow in color, and just ready to burst. The anthers are seized with a fine pair of forceps, broken in halves, and the contents gently shaken or dusted over the feathery style of the female ear. Each flower is treated in succession in this way, and frequently, when the pollen is not in good condition, some of the anthers may be broken and left inside the protective glumes of the flower.

Instead of castrating and pollinating flowers on different days it is generally more convenient to remove the anthers and cross-pollinate the stigmas at the one operation. It is necessary in such cases that the stigma and anthers should be fairly "ripe," and care should be taken that self-fertilization does not occur. Any flowers in which the anthers have already liberated pollen should be suppressed.

After the crossing is finished the ear is wrapped up in cotton wool, or surrounded with a light paraffined paper bag to prevent the possible entry of foreign pollen. The ear is then labelled with the names of the male and female parents, date of cross, etc., and supported by a stake. A fortnight later the protective covering may be removed, and the ear allowed to ripen.

EFFECTS OF CROSSING.

It is interesting to note, in passing, the general effect of crossing two different varieties of wheat:—

(*a*) *Crossing Increases Vigor of Progeny.*—Darwin made an exhaustive comparative study of the effects of self-fertilization and cross-fertilization in plants. He has summed up his researches in the generalization that "Nature abhors perpetual self-fertiliza-

READY FOR CROSSING

At left, a head of wheat before treatment. At right, same head prepared for cross-pollination. (Fig. 18.)

tion." He showed that crossing within the limits of the species resulted in the production of a very vigorous offspring, while self-fertilization tends to weaken the offspring, and that flowers as a general rule are constructed in such a manner as to favor cross-fertilization. In the case of wheat, however, it must be remembered that the flowers are normally self-fertilized, and that cross-fertilization under natural conditions is extremely rare. There can be no doubt that in the cross-breeding of wheat the immediate effect is a general marked increase in the vigor of the cross. This increased vigor finds its expression generally in increased height, increased stooling capacity and size of head in the cross-bred progeny. Whether this increased vigor is, however, a permanent characteristic or a mere temporary improvement has not been definitely established in the case of wheat.

(*b*) *Crossing "breaks the type"* and induces variation. Cross-breeding is one of the most powerful methods of inducing variations in a given type. There is no variety of wheat grown at the present time but what has some serious defect. It frequently happens that given varieties are specially well dowered with certain desirable qualities, but are sadly deficient in other necessary qualities. It is now possible by systematic cross-breeding to combine the desirable qualities of two or more individual types in one variety, and eliminate any undesirable qualities. Farrer relied almost entirely on this method for the production of his new varieties. Federation, the most popular and prolific wheat in general cultivation in Australia at the present time; Cedar, Bobs, and Comeback, wheats of the highest milling excellence; Florence and Genoa, varieties which are smut resistant; and Bunyip, Thew, Bayah, Firbank, Warren, Jonathan, and a host of others have been produced by Farrer by means of cross-breeding. It is by means of the variations induced by crossing that improvement on existing types becomes possible.

Obviously, the wider the initial differences between the two plants the more widely will the progeny vary.

Some idea of the difficulties which beset the early workers on this field of inquiry may be gathered from the history of a typical cross-bred seed. Suppose, for example, the variety known as Clubhead, which is a stiff-strawed, beardless, dark-chaffed variety with a dense compact head, be crossed with Yandilla King, which has a long, white, somewhat open head with firm closing glumes. The plants of the first generation will invariably be slightly clubby in character with reddish-brown chaff. Now from this single cross-bred plant a thousand seeds might be produced. If every one of these seeds be separately sown the next season an unending variety of plants will arise.

Every gradation and combination between the characteristics of the Clubhead on the one hand and the Yandilla King on the other appear to make themselves manifest in this generation. Indeed, characters appear in this generation which were latent in the originals, *e. g.*, many of the progeny will be found with beards. Apparently chaos is the result of this simple act of crossing. Further, if a few grains be selected from each of the thousand plants and again be sown separately, it will be found that in the third generation some of the plants breed true to type whilst others give still further complex variations. This apparently chaotic result arising from the growing of a single cross-bred seed puzzled and confounded the early hybridizers and investigators. If by cross-breeding plants possessing specific characteristics the progeny were found to obey no definite laws it follows that the improvement of plants by this method would be nothing more than a mere gamble.

Lindley, indeed, some fifty years ago, declared that the improvement of plants by cross-breeding was a game of chance with the odds in favor of the plant.

If, on the contrary, the laws of inheritance of specific characteristics could be formulated and definitely known it manifestly follows that the work of plant improvement would be reduced to scientific exactness.

Gregor Mendel, monk and abbot, of Brünn, in Austrian Silesia, was the first to unravel this tangle, and present to the world a clear and lucid exposition of the inheritance of specific characters in cross-breeding.

Mendel's work has been confirmed by many workers in widely different fields of investigation. Besides Correns, Tschermak, and De Vries, who were responsible for the rediscovery of Mendel's work, there have been confirmatory contributions by Darbishire on Mice, Hurst on Rabbits, Davenport on Poultry, Vilmorin, Nilsson-Ehle, Biffen, Spillman, and Howard on Wheat, Bateson, Saunders, and others on Lychnis, Atropa and Matthiola, and Toyama on Silkmoths, to name only a few.

MENDELISM IN WHEAT.

It is of great practical importance to know whether the laws of inheritance formulated by Mendel and developed by his successors may be applied in practice to the improvement of wheat. A considerable amount of data has accumulated during recent years on the inheritance of unit characters in wheat, and this tends to show that—

(1) The process of "fixing" new crosses, which formerly required considerable time and a vast amount of labor, may be greatly simplified.

(2) The wheat breeder can predict with a tolerable amount of certainty what combinations of unit characters may be associated and fixed in a new variety.

(3) The breeding of new varieties possessing certain specific attributes and desirable qualities may be accomplished with certainty.

The most prominent investigators in this field of work are Tschermak,[14] Spillman,[15] Biffen,[16] Nilsson-Ehle,[17] and Howard.[18] The first essential, of course,

[14] *Tschermak*—Die Züchtung der landw. Kulturpflanzen Bd. IV., 1907.
[15] *Spillman*—Science XVI, 1902.
[16] *Biffen*—Journal of Agri. Science, 1905, 1907, 1908, 1909.
[17] *Nilsson-Ehle*—Kreuzungsuntersuchungen an Hafer und Weizen Lund, 1909–1911.
[18] *Howard*—Memoirs of the Imperial Dept. of Agric., India, Vol. IV, No. 8, Vol. V, No. 1.

is to determine what characteristics in wheat are dominant and what recessive. Tschermak after an exhaustive and critical study of the behavior of the various contrasted unit characters in wheat states that the following attributes are respectively dominant and recessive, in strict accordance with Mendel's law:—

WHEAT ALLELOMORPHS.

Dominant.	Recessive.
Hairy leaves.	Smooth leaves.
Solid stem.	Hollow stem.
Firm closing of glumes.	Loose closing of glumes.
Felted glumes.	Smooth glumes.
Black chaff.	White chaff.
Flinty grain.	Floury grain.
Winter form (late shooting).	Spring form (early shooting).
Lax ears.	Dense ears.

These have been confirmed in general by Biffen and Spillman, though in the case of bearded and beardless wheats the ratios are often very far from following Mendel's law, as Saunders,[19] Howard and others have pointed out.

Biffen has obtained similar results at Cambridge. In addition he has shown that the following characters behave as Mendelian units:—

Dominant.	Recessive.
Red Grain.	White Grain.
Hard translucent endosperm.	Soft opaque endosperm.
Susceptibility to yellow rust.	Immunity from yellow rust.

In the following characters there is no dominance of either character, and the progeny in the first generation are intermediate:—

Lax and dense ears.
Large and small glumes.
Long and short grains.
Early and late ripening.

In the second generation two of the intermediates occur to each pure character—D:2DR:R.

The determination of the mode of inheritance of these various unit characters is of the greatest practical importance, for it enables the breeder to predict with tolerable certainty the forms resulting from the mating of two plants whose qualities can be expressed in terms of one or more unit characters.

One of the most interesting of the researches carried out in the production of new varieties of wheat is that done by Biffen in the production of the apparently impossible combination in the one variety of prolificacy, resistance to yellow rust, and high strength.

The wheats grown in England are very low in strength, and this defect is reflected in the disparity in price at Mark Lane between the Home-grown wheat, and the strong foreign wheats like Manitoba No. 1. It was formerly thought that this low strength of the wheats grown in England was due to the peculiarities of the climate.

A trial of a large number of foreign varieties of high strength under Englsh conditions proved that while the greater majority deteriorated immediately, there were a few varieties which retained their strength perfectly under the new climatic conditions, and gave as good results in the bakehouse as when grown in their native lands. These varieties, however, were of little use to English farmers, for they lacked yielding power of both grain and straw. Biffen, therefore, crossed these varieties of high strength with the prolific English varieties with the object of obtaining suitable varieties of high strength. Strength is defined as to the capacity of the flour "to yield large well-piled loaves," and while it is not an easy matter to give in non-technical language the difference between strong and weak wheat, it may be said that in general strong wheats are characterized by hard, more or less transparent endosperm, whilst weak wheats are usually soft, starchy, and opaque. In a certain cross between Red Fife and Rough Chaff a statistical examination of the progeny revealed the fact that in the first generation all the plants possessed strong grain, and that in the second generation the strength and weakness behaved as Mendelian characters giving the following ratio:—Nine strong red, three strong white, three weak red, one weak white. Biffen showed that these characters of strength and weakness in wheats could be handled with the same definiteness as other Mendelian characters.

[19] Saunders, Inheritance of Awns in Wheat, Conference on Genetics, 1906, p. 370.

CROSS-POLLINATING WHEAT FLOWERS

In order to combine the desirable qualities of several strains in one, the breeder resorts to cross-pollination. To do this he removes part of the flowers from a head of wheat, as is shown in this photograph, and then removes the anthers or pollen sacs from all the remaining flowers. These, in which only female or pistillate organs remain, are known as the seed-bearing parent of the cross. Some other variety is selected as the male or pollen-bearing parent, and from flowers of such variety the anthers are cut out and burst over the flowers of the seed-bearer, their pollen falling on the stigmas of these flowers and causing cross-pollination by the method shown in the preceding photographs. After pollination has been made, the flowers are protected by a wrapper of cotton batting, in order to avoid the possibility of any subsequent pollination by wind or insects, which might seriously interfere with the breeder's plans by changing the heredity of the resulting seed. (Fig. 19.)

Similar results were obtained with the inheritance of yellow rust (*Puccinia glumarum*) which does great damage in England.

Crosses between varieties which were immune from yellow rust and Michigan Bronze, a variety inordinately prone to rust, gave a first generation crop of hybrids which were as badly affected with rust as Michigan Bronze itself. A statistical examination of the second generation plants gave 1,603 diseased plants and 523 immune, or a ratio of 3.07:1. Apparently, therefore, immunity and susceptibility to yellow rust behave like Mendelian characters.

It is not known to what the resistance of the rust is due. Working with Professor Biffen, Miss Marryat found that the rust hyphæ are checked after entering the stomata of the resistant plants. Bateson points out that if the resistance to yellow rust is due to the presence of some anti-toxin the dominance of susceptibility must be taken to indicate that the formation of the anti-toxin is prevented by the presence of a factor in the dominant form, a conclusion which may lead to definite progress in the physiology of disease resistance. This yellow rust (*Puccinia glumarum*) is not the rust so frequently found in Australia wheat fields. The species of rust which causes so much damage here is *Puccinia graminis*.[70]

Many of the unit characters so far studied in wheat have been those which are of relatively little value to the practical agriculturist. The color of the chaff, the character of the awns, the hairs on the glumes, etc., are of great interest from a scientific point of view, inasmuch as a systematic study of them will serve to throw much light on obscure problems of inheritance, but they are of infinitely less practical utility than such characteristics as prolificacy, drought resistance, and early maturity.

Unfortunately very little work has been done in regard to these important practical properties, and a systematic analysis of the factors on which these qualities depend, and of their mode of inheritance, is urgently required. We do know that the prolificacy of any variety of wheat is a complex of many factors. The yield depends on the climate; the chemical, physical, and biological condition of the soil; and on the qualities inherent in the variety.

Of the qualities inherent in the variety the most important are the capacity to develop a vigorous root system, and to stool thoroughly. Other factors are the average length and density of the ears—the number of fertile florets carried to each spikelet, and the average size of the grain. We do not know, however, as yet whether high yielding and low yielding capacity behave as Mendelian characters and segregate as such in the second generation.

CONCLUSION.

During the past few years efforts have been made by ardent enthusiasts to extend Mendel's law to all branches of animal breeding, and to make it fit in with our present day knowledge. Interesting results have certainly been obtained in the cross-breeding of poultry, mice, rabbits, and polled cattle, but a considerable amount of ingenuity will be required to explain many of the discrepant and discordant results obtained with sheep and pigeons, etc.

Whatever the future may have in store in the practical application of Mendel's work to animal breeding, there can be no doubt that the present day breeder can, with the aid of the key given by Mendel, proceed on his work of plant improvement without leaving much to chance. The best results will follow when the individual plant is regarded as being built up of a number of unit characters, each of which follows a definite scheme of inheritance. The terms dominance and recessiveness should be applied, not to individual plants, but to each of the unit characters which collectively make up the organism. The schemes of inheritance of many of the unit characters have been worked out in detail, but there are qualities of great practical importance which require further investigation. We require to know exactly what are the

[70] *Puccinia graminis* is the late stem-rust of the United States. The early orange leaf-rust of the U. S. is *P. rubigo-vera*.—The Editor.

various factors on which these important qualities depend, whether they conform to the Mendelian scheme of inheritance, and whether they are transmitted independently of other factors, or in association, and, if so, how close the association is.

The aim of the wheat-breeder is always an improvement in type, the production of varieties possessing the maximum of desirable qualities, and the minimum of undesirable attributes. If he knows that the desirable qualities he is seeking are in two or more strains it is his task to unite the desirable qualities in the one strain. His most important problem is to determine by analysis and experiment the factors on which the desirable characteristics depend. But as soon as these factors have been determined, and their mode of inheritance investigated, they can be brought under control and associated together at the breeder's will.

SUMMARY.

1. The enriching and improving of the soil has been the dominant note in our system of wheat farming during the past generation.

2. There is reason to believe that as much attention might profitably be given to the improvement of the plant as there has hitherto been given to the improvement in its environment.

3. The primary aim of wheat improvement is the production of prolific varieties. Other important considerations are milling quality of grain, drought resistance, and rust resistance.

4. Extraordinary activity is being displayed throughout the world in wheat improvement.

5. Varieties may be improved by selection and cross-breeding.

6. Every care should be taken by farmers to get (*a*) the right variety of wheat, (*b*) well-developed seed, (*c*) seed from the most vigorous plants.

7. The common beet containing 6 to 7 per cent. of sugar has been developed into the sugar beet containing 20 to 25 per cent. of sugar by systematic selection.

8. Selection is based on variation.

9. Most variations are small, and diverge only slightly from the mean of the species. Others are large, and vary widely from the mean (mutations).

10. There are two general methods of selection: (*a*) mass selection, (*b*) individual selection.

11. "Mass selection" has been effectively applied by farmers to the improvement of their crops. It must be continuous and uninterrupted.

12. "Individual selection" is more complicated, and requires elaborate records and trials for its successful application.

13. The introduction and acclimatization of certain foreign varieties is likely to lead to valuable direct and indirect results.

14. New varieties may also be obtained by cross-breeding.

15. The immediate effects of cross-breeding in wheats are (1) increase in vigor of progeny, (2) a "breaking of type."

16. Mendel showed that the variations induced by crossing follow definite laws.

17. Mendel's results have been generally confirmed by workers in widely different fields of inquiry.

18. The mode of inheritance of many unit characters in wheat has been worked out in detail.

19. The mode of inheritance of other characteristics in wheat of great practical importance has not yet been worked out.

20. The well informed wheat improver may enter on his task of wheat improvement without leaving much to chance.

EUGENIC LEGISLATION

Much of it Worse than Useless Because Based on Lamarckian Theories—Other Statutes Sound Biologically but Wrong Sociologically—Need for Caution but Possibility of Positive Achievements.

A Review.

STUDENTS of human heredity will view with satisfaction the appearance of bulletin No. 82 of the University of Washington,[1] which gives in 87 pages a summary of the laws of the several United States governing: I.—Marriage and divorce of the feebleminded, the epileptic and the insane; II.—Asexualization; III.—Institutional commitment and discharge of the feebleminded and the epileptic. After giving summaries of all the laws in question, in a clear and concise form, the authors terminate their work with four pages of temperate discussion of the entire subject of legislation intended to prevent the breeding of a degenerate race in the United States, pointing out that some of this legislation is so out of date, from a biological point of view, that it is worse than useless.

"A half century ago," they remark (p. 82), "educators still hoped by intensive education so to improve the mental condition of the feebleminded as to make advisable their leaving the institution and assuming some, at least, of the duties of normal people. If this policy of the educators were to benefit society, it must have presupposed that acquired traits are, in the full meaning of the term, inherited. And this no one at that time doubted.

"Today we know that nearly all forms of mental deficiency are incurable, and most biologists believe that, in the full meaning of the term, acquired characters are not inherited. Legislatures, however, have other tasks than the study of modern biological theory, so that we see the opinions of Lamarck and of Seguin almost unchanged in many of the state laws.

"For instance, a number of institutions for the feebleminded are intended only for those who 'may be benefited by the instruction.' The Illinois application blank indicates this. The governor of New Jersey is empowered to remove any child who is not benefiting by the instruction given. Delaware, which sends its feebleminded to the institutions of other states, orders its patients discharged when they may no longer receive benefit from training. In Kentucky the superintendent of the institution is supposed to return to the counties all patients, further attempts to educate whom will not prove beneficial to the state. Also, no child may be kept in the institution after arriving at such age and mental condition that he will be able to provide for himself.

EDUCATION NOT A REMEDY.

"Regulations such as these are not often put to any greater use than necessary, but they still reflect the opinion of a few decades ago, that the superficially educated defective makes better material for parenthood than the uneducated defective. To discharge, unsterilized, the defective child, after having taught him habits of neatness and a few tricks that make his mental deficiency less noticeable, is worse than never to have put him in an institution. The same criticism applies, of course, to the special classes in the public schools.

"Among the marriage and divorce laws there is more Lamarckian biology. Kansas forbids the marriage (unless the wife is over 45 years of age) of children

[1]The Bulletin of the Univ. of Washington no. 82 (Seattle, Wash., May, 1914), "A Summary of the Laws of the Several States, etc.," by Stevenson Smith, Madge W. Wilkinson and Lovisa C. Wagoner of the Bailey and Babette Gatzert Foundation for Child Welfare.

born after a parent was insane. Michigan and New Jersey demand the 'cure' of defectives before marriage. Divorce is granted in Utah on the ground of insanity only when the condition is incurable.

"The Michigan asexualization law provides for sterilization when 'there is no probability that the condition of such person so examined will improve to such an extent as to render procreation by such person advisable.' A similar provision is found in the North Dakota law."

The authors go on to point out that some sterilization measures which are sound biologically may be quite wrong from a sociological point of view. In such a case, legislation must proceed very slowly. Finally they discuss briefly the whole question of whether laws to prevent bad breeding are feasible.

"A frequent charge made against eugenic legislation is that it is unwise, that it is conceived in the isolation of the schools and will never bear the test of common use. Our attention is called to the many Utopias which have come to pass only in the minds of philosophers, and to the failure of most 'ideal' communities due to their disregard of common-sense premises.

"Another objection to such laws is raised by the 'all for love and the world well lost' school. In their opinion, even granted that by the exercise of the police power it were possible to realize this academic dream, the Eugenic State must necessarily be a cold blooded breeding station where romance is the price paid for a better race.

"Then there are theological objections. These apply especially to asexualization. It is the opinion of some people that although to operate on a man for his own good is justifiable, to operate on him for the good of society is to tamper with the plans of Providence. One also hears it said by people who are not avowedly actuated by theological considerations that such operations are 'unnatural.'

"Lastly, the position is taken that eugenic laws are impracticable, that society will not tolerate them. To be sure, society has tolerated sex taboos and legal penalties much more onerous, but long standing has made them seem 'natural.'

OBJECTIONS EASILY ANSWERED.

"The objections, then, to the legislative attempt to apply the known facts of biology to the betterment of human stock are (1) that the laws themselves would not accomplish what their authors predict, or (2) that the cost of reform is too great, or (3) that the laws are impious, or (4) that society is incorrigible and the laws cannot be enforced. In addition to these, Mr. G. B. Shaw has said that we do not know what type of human being we wish to develop, but as the opinion of society has in the past been a great factor in determining the survival of individuals, this objection holds only within certain limits. We are rather confident that there are certain characteristics we might wisely eliminate.

"To take issue with these antagonistic criticisms of eugenic legislation is hardly the purpose of this publication, though a few of the more obvious rejoinders may be noted. The inheritance under certain conditions of mental deficiency is undisputed. Also the fact that mental defectives are undesirable seems evident. With such a backing for the project, the further social control of the defective deserves being tried out. Ultimately every social measure must survive or be eliminated according to the results of its practical application. To call legislation experimental is to praise it. If less legislation were regarded as final and more were measured by its results, we might have a better working code.

"The second objection is due to ignorance of the history of sex taboo. When it is realized that the present limitation of our individual liberty in the matter of marriage is tacitly accepted by nearly everyone, and that certainly in the past much of this limitation was ridiculous, the objection to further limitation of a desirable sort falls to the ground, especially as in the change many of the present useless taboos will be eliminated. The taboo against incest, that of the Jews against all exogamy and our own

against mating with certain alien races are not irksome to the average man. They rather add to the romance of marriage. An aristocratic pride of race is not antagonistic to a man's choice of a mate, but rather determines it and adds ultimately to his satisfaction. Certainly marriages are happiest when a wise taboo is respected.

"It seems hardly necessary to meet the theological objections to progressive legislation along biological lines, as some theologians are among the ablest supporters of eugenic laws, and those who are not would not agree with the premises of eugenics. A bishop, recently addressing a university audience, condemned the eugenic movement, saying that the selection of the more fit only limited the field of religion, as it is the unfortunate who need religion most. Fortunately this is not a prevalent view in any church.

NEED FOR PUBLIC SENTIMENT.

"In supposing that eugenic laws cannot be enforced, critics doubtless have in mind what they regard as analogous cases of laws which were enacted and became dead letters because the public did not feel their importance. Anti-tipping laws are examples of this, and the public certainly must demand such a law in advance of its enactment if it is not to die on their hands. Much eugenic legislation is, however, not prohibitory in character, but is permissive of certain powers on the part of the courts or of commissions appointed for a definite purpose. It is this sort of legislation that must necessarily work best, as it is not subject to violation and will continue to be used as long as even a few people are intelligently interested in it.

"Whatever may be said against such laws as are presented in this pamphlet, and they are rightly subject to much criticism, it is evident that something must be done to diminish the number of mental defectives in our population. War among primitive people, poverty, disease, and capital punishment did a fairly thorough if not a very beautiful piece of work before we began to civilize them away. Some substitute has to be found for natural selection. Procreation of the undesirable must be prevented by means which are least cruel and least wasteful. These laws already in force in the several states indicate the growth of this opinion."

Crosses With Zebu Cattle

Crosses between zebu and native Italian cattle, made at the zöotechnical institute of Perugia, are discussed by Director Carlo Pucci in L'Agricoltura Coloniale, No. 10, 1914. The results convince him that (1) in all the first generation progeny the zebu skeleton, dewlap, ear and musculature seem to be dominant; (2) the skin color and size of horns of the zebu seem to be recessive; (3) in general, all the progeny show great activity and endurance; (4) they have a very valuable predisposition to lay on weight; (5) they have a very high resistance to the foot and mouth disease.

Pollination of Cherry Trees

That cherry trees frequently prove shy bearers because of inadequate pollination has been demonstrated at the state agricultural experiment station in Oregon. It is found that some of the leading commercial varieties are practically self-sterile, while others are inter-sterile; that is, some varieties are much better pollenizers than others for orchard planting. Sometimes pollination works well in one direction, while the reciprocal cross produces very little fruit. It thus becomes necessary for cherry growers, particularly in regions where only a few varieties are produced, to study each individual variety and find out its needs in pollination, if they would avoid disaster. Inter-sterility among varieties is found not to be correlated to closeness of relationship.

The

Journal of Heredity

(Formerly the American Breeders' Magazine)

Vol. VI, No. 4 April, 1915

CONTENTS

The Journal of Heredity is published monthly by the American Genetic Association (formerly called the American Breeders' Association) for the benefit of its members. Canadian members who desire to receive it should send 25 cents a year, in addition to their regular membership dues of $2, because of additional postage on the magazine; foreign members pay 50 cents extra for the same reason. Subscription price to non-members, $2.00 a year, foreign postage extra; price of single copies, 25 cents.

Entered as second-class matter February 24, 1915, at the postoffice at Washington, D. C., under the act of August 24, 1912.

Date of issue of this number, March 25, 1915.

A CONGENITAL BLAZE IN THE HAIR

The white lock of hair here shown is hereditary and has been traced definitely through six generations; family tradition traces it on back to a son of Harry "Hot-Spur" Percy, born in 1403, and superstitiously assigns its origin to "pre-natal influence" or "maternal impression." This young woman, who is designated as V. 13 in the pedigree chart of the family (Fig. 10), inherited the blaze from her father, who had it from his mother, who had it from her father, a Dr. Little who emigrated to America from England nearly a century ago. The trait appears to be a simple dominant, following Mendel's Law, in its distribution; that is, when a person with one of these locks marries a normal person, half of the children show the lock and half do not. (Frontispiece.)

See "Heredity of White Fore-lock," p. 165.

THE WHITE LEGHORN

A Masquerader Who Conceals Many Colors and Patterns Under Her Pure White Plumage—Results of Genetic Breeding—Need for New "Standard of Perfection" Telling Not How Fowls Ought to Look, but How They Ought to Breed.

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NOTWITHSTANDING the many years that several varieties of poultry have been bred, the fact remains that we are still ignorant of the actual constitution of practically all of them, so far as the character-complex is concerned. Although many breeds have been evolved, and poultrymen refer to these breeds by names which have become standardized through many countries, it must be granted that these breed-names are practically meaningless to the genetist; and in so far as they carry any implication other than that of the *appearance* of the breed, they are also quite as meaningless to the poultryman. An example of what is meant is to be found in the case of that variety of fowl ordinarily called the White Leghorn, of somewhat uncertain origin.

The White Leghorn, which at present happens to be one of the most popular breeds, is ordinarily a pure white bird without pattern or markings, the beak and shanks being yellow. No other pigment is manifested. The eye is ordinarily bay. The white plumage color, unlike that of most white breeds, is a dominant white; that is, in crosses with black breeds the black is recessive. So long as the White Leghorns are bred among themselves, no other characters appear. Properly devised cross-breeding, however, tells a different story, and it is the aim of this paper to review briefly the results of experimental studies which demonstrate what sort of a bird the White Leghorn really is with respect to some of her breeding capabilites.

If a White Leghorn male is mated with a self-colored black like the Black Hamburg, Black Minorca, Black Spanish, or Black Langshan, the first generation progeny are commonly white. Close inspection, however, will reveal in the feathers of most of the birds minute flecks of black. Sometimes these are large enough to amount to actual splashes and occasionally one may find in the wing coverts or tail a feather which has several bars near the tip. All the birds are, however, mainly white. The Leghorn white is dominant over black.

THE SECOND GENERATION.

If, now, these F_1 birds are mated together, F_2 gives something of a variety of colors and markings. Among every sixteen adult birds, twelve are white and four are dark colored. The dark colored birds are found to include three that are barred and one that is black. Of the barred birds, two are males and one is a female. The one black individual in the sixteen is always a female. The barred birds are usually fully barred, but the character of the barring is inferior to that of the standard Barred Plymouth Rocks. The bars are less regular and the background is likely to be gray or smoky. There is, however, no question regarding the fact of the barring. One of these barred birds together with its parents and grandparents (White Leghorn and Black Hamburg) are shown in some of the figures accompanying this article.

The question at once arises—What is the origin of this barred pattern which

FIG. 1.—Explanation on opposite page.

makes its appearance in F_2? It cannot have come from the Black Hamburg grandparent since we know that in every case where the factor for barring is added to black pigmentation, the barred pattern is brought out. It must therefore have come from the White Leghorn. In other words, the White Leghorn itself carries factors for this barred plumage pattern.

BREEDING BLACK FROM WHITE.

But this is not all. If a White Leghorn male be mated with a White Plymouth Rock or a White Silky female or with any other bird carrying recessive white, the first generation progeny are white, sometimes manifesting on close inspection a few black flecks in the plumage. No colored birds result. Now suppose these F_1 white fowls are mated together. One would naturally expect nothing but whites to result. But this is not the case. Among every sixty-four adult individuals, there appear approximately twelve birds that are dark colored —either barred or black, depending upon the cross used. It may now be asked whence came the black birds in a cross in which the original parents were pure white? In the case of the White Plymouth Rock mating, we know that the White Plymouth Rock parent could not have introduced the black because, whenever a black factor is added to a recessive white carrying the barring factor, the pattern becomes patent and the bird becomes a Barred Rock or "Cuckoo." We are therefore forced to one of two conclusions: (1) Either the White Leghorn parent contributed the black pigmentation or (2) the pigmentation was produced by the conjunction of two factors of which the White Leghorn and the White Plymouth Rock each contributed one. By Mendelian analysis of the experimental results,, this question can be answered. It results in this: If one of these factors for black (X) comes from the Leghorn, and the other (Y) comes from the White Plymouth Rock, then the number of dark colored birds in F_2 is nine in sixty-four. If on the other hand, the White Leghorn introduces all the factors necessary to determine black pigmentation in F_2 progeny, the number of dark colored birds would be twelve in sixty-four. In the actual experiments carried out at the Rhode Island Agricultural Experiment Station, among 167 F_2 birds raised from the mating in question, thirty-three were dark colored and 134 were white. The expectation was dark colored, 31.2; white 135.8. It can therefore scarcely be doubted that the White Leghorn male carries in its germ cells all the factors necessary for the determination of black pigmentation in the F_2 generation of crosses with non-pigmented breeds.

THE FACTS EXPLAINED.

Now what is the explanation of these phenomena? It has been stated that the White Leghorn possesses a dominant white. But white in the plumage of poultry is merely the absence of color and the absence of color can scarcely be dominant over the presence of color. It must be assumed therefore that the Leghorn white is due to some positive inhibiting factor (I) which in some way is able to repress or to neutralize the black pigment, not only in its own somatic cells, which would otherwise show black, but also in crosses with other black breeds. When I is present

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THE WHITE LEGHORN UNMASKED.

(See illustrations on opposite page.)

Although the White Leghorn is considered a "pure breed," it is very far from being a pure breed, from a genetic point of view. Its germ cells even contain a factor for barring, so that barred fowls can be produced from certain matings of pure white fowls. Upper left is a White Leghorn male, which was mated with a White Plymouth Rock female such as is shown in the lower left. From this cross resulted birds like the one shown in the upper right—nearly solid white, but with occasional black splashes. When these birds are bred together, a definite proportion (12 in 64) of the offspring are barred, like the bird shown in the lower right. Further analytic breeding proves that this barring is carried in the germ-plasm of the White Leghorn, not the White Plymouth Rock. (Fig. 1.)

in homozygous condition, black pigmentation is held completely in control; when I is present in a heterozygous condition, as in the F_1 cross-breds, the effect is diminished, and a little black frequently shows as minute flecks in an otherwise white plumage.

This factor for the inhibition of black is apparently present normally in both male and female White Leghorns in homozygous condition, and is not sex-limited in its manner of inheritance. For the barring factor, however, the White Leghorn male appears to be homozygous and the female heterozygous. The presence of these two factors explains many curious results that have been obtained by poultrymen when they have employed in crosses the White Leghorn breed.

But these are not all the factors of interest that the White Leghorn carries in the germ cells but does not show somatically.

If a White Leghorn male be crossed with a White Silky female, the dark mesodermal Silky pigmentation of the beak, shanks and face is reduced in the F_1 cross-breds to an intermediate grade. The plumage of such birds is white, with a few black flecks, and the males resemble the females not only in these points but also in the color of the irides which are lighter than in the Silky parent and sometimes almost as much of a bay as in the White Leghorn itself.

If, however, in a cross of this sort, the male parent is the Silky and the female parent is the Leghorn, the results are different. The males will be found to show little of the Silky pigmentation in beak, shanks, eyes or face, and their plumage is almost a pure white. But the females show the deeper Silky pigmentation in all these structures and the white feathers of the wings and back are heavily splashed with black. Similar results are obtained when the White Leghorn is mated with some other heavily pigmented breeds like the Black Langshan,[1] and when the Brown Leghorn is crossed with the White Silky.[2]

Here then we have to do with another inhibitive factor (I') which acts (possibly in conjunction with the first inhibitor, I) not only upon the black plumage pigment of ectodermal structure, but also on the deeper mesodermal pigmentation. While the first inhibitory factor mentioned does not appear to be a sex-limited character, this second inhibitor does appear to be correlated with sex. It is transmitted from the male Leghorn to both male and female progeny, but by the female Leghorn it is given to the sons only.

OTHER COLORS HIDDEN.

In addition to these inhibitors of black pigmentation, the White Leghorn also possesses inhibitors for buff and red. These colors are, however, repressed less perfectly than black; and red, as might be expected, less perfectly than buff. Whether the factors that inhibit these colors are identical with the inhibitor of black cannot now be stated. Nor would it be safe to affirm that there are not still other unrecognized factors modifying pattern and plumage color carried by this interesting breed. In any case the above facts are sufficient to show that the White Leghorn is something of a masquerader. Her appearance gives us little knowledge of what lies beneath her cloak of white. And if the White Leghorn, after a little study of her constitution, gives us such new conceptions of her character complex, what shall we expect of some other breeds, of which we still know comparatively nothing?

What the poultry world of today needs, in addition to the Standard which tells how poultry ought to appear is a Standard which will tell *how the varieties ought to breed*. It would be a great help to poultry breeders if each different breed should have its zygotic constitution represented by a formula designating, so far as possible, all the important characters possessed by that breed, thus indicating the breeding values. For instance, in the case of the White Leghorn the following symbols might be used to cover the characters already mentioned.

[1] *See* Lewis, H. F. Jour. of the Amer. Assoc. of Instructors and Investigators of Poultry Husbandry, Vol. 1, No. 2, 1915.

[2] *See* Bateson, Wm. and Punnett, R. C., Jour. Genetics, Vol. 1, No. 3, 1911.

F = femaleness
N = black pigmentation
B = barring factor
I = inhibiting factor No. 1
I′ = inhibiting factor No. 2

and the constitution of the male written

$$f_2N_2B_2I_2I'_2$$

while the White Leghorn female being heterozygous for three factors would be

$$FfN_2BbI_2I'i'.$$

Using these same symbols, the White Dorking, another dominant white breed, but lacking both the latent barring and black would become, male,

$$f_2n_2b_2I_2i'_2$$

and the female essentially the same,

$$Ffn_2b_2I_2i'_2$$

The White Plymouth Rock, a recessive white, which differs from the White Leghorn only in the lack of the factors for black pigmentation and for the inhibitors I and I′, would be represented, male

$$f_2n_2B_2i_2i'_2$$

and the female

$$Ffn_2Bbi_2i'_2$$

The White Silky with its black mesodermal pigmentation' (M) would be, male,

$$f_2M_2n_2b_2i_2i'_2$$

and the female

$$FfM_2n_2b_2i_2i'_2.$$

These illustrations are sufficient to indicate what is meant by standardizing breeds of poultry. Of course the breeds alluded to above have many other characters that would also be listed in the Standard formulae, and other breeds would possess their own character-complexes, or aggregations of unit characters. But the main point is, that if breeds were so standardized, and listed, a poultryman would know what he was purchasing when he acquires a certain fowl. He would know not only how the bird looked, but how that bird will breed; and it seems as if this point might be of interest and possibly of importance to poultrymen who are also poultry breeders.

Plant Breeding Correlations

Fundamental principles useful in apple breeding are being studied particularly at the Iowa state agricultural experiment station. One object is to determine what features are of taxonomic value in distinguishing horticultural varieties with certainty; another is to find correlations which may be used in practicing intelligent selection with young seedlings without having to grow each plant through to maturity in order to determine its characters. A large factor in the success of most great plant breeders has been their marvelous ability to judge by looking at a small seedling, what it would be likely to produce when it reached maturity. This ability has often seemed mysterious, but as a fact it must necessarily depend largely on the observation of correlations not appreciated by the ordinary horticulturist, and perhaps not definitely formulated by the talented breeder himself. The Iowa station wants to reduce this mystery to mathematical formulae and put it in the reach of every one of intelligence; already hardiness has been found to be correlated with structure and composition in a definite way.

Johannsen to Visit America

Dr. W. Johannsen of the University of Copenhagen, Denmark, is expected in the United States this summer to join the faculty of the University of California Summer Session at Berkeley. He has been invited to attend the meeting of the American Genetic Association at Berkeley, August 2-7. Dr. Johannsen is one of the pioneers in the application of mathematics to biological problems, and is particularly well known in genetics for his enunciation of the theory of "pure lines."

INFLUENCE OF STOCK ON CION

In Grafted Trees, One Parent Usually Modified, Sometimes Both—Explanation of the Changes—Remarkable Almond Grafts in California.

B. S. Brown

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MUCH has been said in recent years regarding the effects of graftage upon the co-joined parents. That there is a very decided difference in certain fruits when grafted upon different stocks no one will deny. But to what extent these influences represent fixed or dependable characters is still an open question.

The best recognized example of reciprocal influence is the dwarfing of certain standard fruits when grafted upon smaller stature plants. Thus pears are put upon quince or apples upon doucin or paradise stock[1] for this purpose. While slow-growing stocks tend to reduce the stature of plants grafted upon them, the converse of this is also true, that rapid-growing stock will stimulate the growth of naturally dwarf plants. While quince stock will reduce the size of a pear tree, a pear stock will increase the stature of a quince that is worked upon it. This is not only true in the above relation but also where conditions are reversed. That is, pears grafted on quince stock will stimulate greater root growth to the quince. Another oft-cited example of this same condition is the influence of standard apples when grafted on stock of the Siberian Crab. Such a union always stimulates the root system of the stock to a larger size than it would grow naturally.

Because of the commercial importance of the subject, growers of all kinds of fruit are now attempting to find out definitely the reciprocal influence of various kinds on each other. One of the interesting experiments is that made by grafting tomato on belladonna, when analysis showed that the tomatoes borne contained an alkaloid allied chemically and physiologically to atropin, whereas tomatoes do not normally contain any such substance.[2]

The California agricultural experiment station has been conducting a series of experiments to determine the exact results in various grafts on citrous fruits. One of the interesting results, which may serve as a specimen of many, is that when lemons are budded on the hardy, savage, Japanese, three-leaved species (*Citrus trifoliata*), they are dwarfed, and the diameter of the trifoliate stock, below the bud union, is nearly always increased.[3]

While investigating the almond industry in Central California recently, I discovered a peculiar case of reciprocal influence of stock and cion, to which it may be of interest to call attention. An orchard of 10 acres had been set to peaches and then a year later top-worked to almonds, the union being made just above the ground. The orchard had been in existence for 42 years and contained many trees as sound as they were at the age of five.

Many of these trees were 50 feet high and ranged from two to three feet in diameter. Figures two and three are individual trees in this orchard, showing the peculiar enlargement at the point

[1] Doucin and Paradise are types of wild apple, probably of central Asian origin, which are widely grown for stock on which to bud cultivated varieties of apple. In the past they have been considered distinct species but at present are held rather to be trade names, each one embracing 10 or a dozen varieties of the ordinary apple. Doucin stock is used when "semi-dwarf" trees are wanted, while the use of Paradise stock results in a still greater reduction of size.

[2] See Gardeners' Chronicle, London, May 16, 1914.

[3] This was pointed out 10 years ago by H. H. Hume (Citrus Fruits and their Culture, 1904) and is true of all species and varieties that have been tested on trifoliata stock.

UNION OF ALMOND AND PEACH

This graft is 42 years old and seems to have stimulated both of the parents, since each of them has attained a size which would hardly be expected if it were growing alone. The increased vigor is seen not only in the size, but in the great longevity. Grafted trees are frequently short-lived. (Fig. 2.)

of union of the peach and almond. The larger one (Fig. 2) measures 9′ 1″ in circumference above the union and 10′ 4″ below. The second one (Fig. 3) measured 6′ 6″ above and 9′ 7″ below, making a difference of 3′ 1″ in circumference. In peculiar contrast to the above the same orchard had four rows on the west side grafted on plum stock. These were presumably of the same age, but were from one-quarter to one-half smaller than those on peach root. All but ten had died and been removed while those still living were sickly and contained many dead branches. The plum stock was in every case smaller than the part above the union. Fig. 4 shows one of the trees on plum stock, which measured four feet in circumference below the union and 4′ 10″ above, a decided contrast to the peach stock. The same condition was also observed in other old orchards of similar age.

The union that the peach makes with the almond is exceedingly strong, and usually the peach remains sound longer than the almond. Fig. 5 shows a photograph of a vertical section cut through the union. The line of growth is straight across and very sharply defined.

The section in the center of the picture is a cut through the union of an English walnut and a black walnut, differing from the almond illustration in that the union was made by budding instead of grafting.

From these almond grafts, it will be evident that grafting may increase the size not only of one parent, but of both; and in this case, it seems to have resulted in increased longevity, as well.

Another influence of stock over cion

AN UNUSUALLY FAVORABLE GRAFT

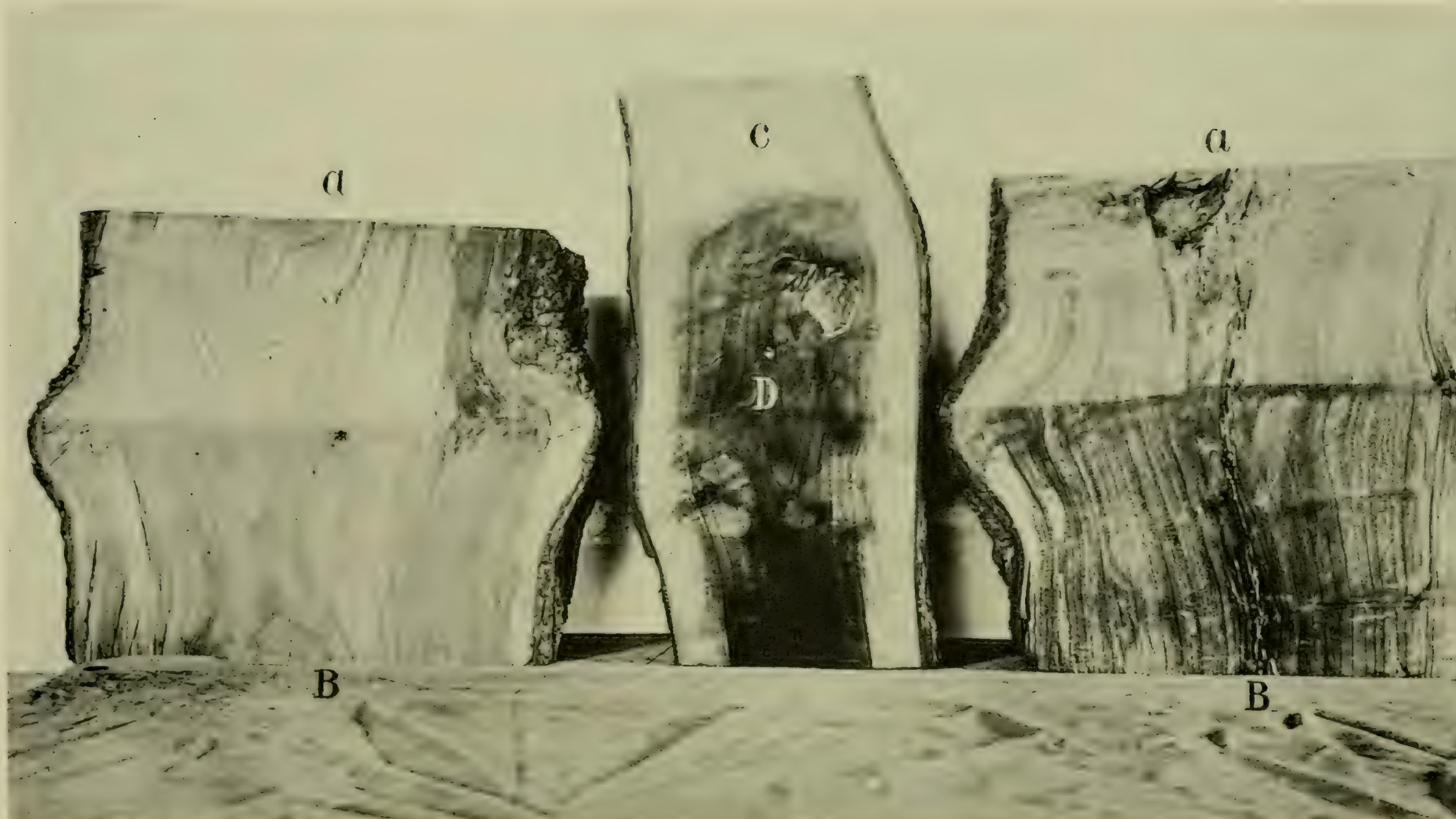
The union of peach with almond is exceedingly strong. In the case of this 42-year-old tree, it is still absolutely sound. Both the stock or root parent, and the cion or top parent, seem to have been stimulated to unusual growth, and this evidently caused an increased flow of sap, which may be responsible for the splendid condition of the tree. (Fig. 3.)

is the early bearing tendency of dwarfed trees. Orchardists everywhere recognize this factor and utilize it in a practical way. Pears on quince stock fruit in three or four years while the standard stock requires from five to eight. Apples on paradise stock will fruit in three years while the same variety on French crab will require from five to eight years. In almost every case this early bearing habit is associated with the dwarfing condition and the two seem to bear a fairly permanent correlation. Also in this same connection it is well to note that dwarfed trees are shorter lived than their full statured relatives. This is well illustrated in Figure 4 where the almond was grafted on plum stock.

Various other known conditions are attributed to this reciprocal influence of grafts, for example, the delay in the blooming period of certain fruits when united with slow growing stocks. Five years ago in one of the sub-stations of the University of California was begun an experiment with almonds to prove this point. It so happens that the almond is the earliest blooming deciduous fruit on the Pacific Coast, blossoms appearing from five to eight days ahead of the peach and from 10 to 14 days prior to most plums. Desirable types of almonds were grafted on both peach and plum stock and their influence on the resulting bloom noticed. Peaches produced little or no noticeable effect while the plum stock retarded the

THE GRAFT OF ALMOND ON PLUM

In this 42-year-old tree, the almond cion has grown well but the plum stock has lagged behind. It was, therefore, unable to furnish as great a supply of sap as the more vigorous top demanded, so most of the trees of this sort, in the orchard seen by Mr. Brown, had died or were dying. (Fig. 4.)



CROSS-SECTIONS OF GRAFT UNIONS

At the sides are transverse and tangential sections through the graft of almond on peach, (a) being the almond cion and (b) the peach stock. The great firmness of the union is noticeable. In the center is a cut through the union of a Black walnut (d) on which an English walnut (c) was budded. (Fig. 5.)

bloom from five to seven days or about half the original difference between the two on their own roots.

Color and flavor of fruits is also influenced more or less by the stock used, but the results are not so easily measured or as well understood. There apparently is no question but that high colored fruits can be improved by grafting upon seedlings grown from high colored fruits. This, however, is more or less of an indefinite quantity, as the seedlings themselves may vary widely in their ability to transmit the high color. Results are more noticeable when seedlings from Siberian Crabs are used, because they are more stable.

What is true of color is also true of the sugar and acid content of the fruit.

Apples low in sugar when grafted upon sweet apple trees will show an increase in sugar content. Undoubtedly some of the poor quality and lack of color in certain regions, attributed to local environment, may be due to the influence of the stock on which they are grafted.

The cause of these varied influences may be attributed to two sources—namely, mechanical and physiological disturbances. This can be more easily understood when we think of the cell as being the plant unit. Each cell performs its own functions. Theoretically the cells of the stock perform all those functions characteristic of the stock, up to the point of the union. Then the cells of the other co-parent take up the work and modify the nature of this work —*i. e.*, the vital processes—in accordance with their own peculiar character. While there is a rather wide division of labor in the functioning powers of the cells of the different organs, there is a more or less definite protoplasmic organization throughout the entire plant tissue. Certain cell substances such as sugar may be differently affected by the cells of each of the co-parents. If the cells of the stock are capable of developing a higher sugar content than the cion, presumably the cells of the latter will not reduce it, hence a decrease or increase in the acid or sugar content is influenced by the stock. Of course this is relatively a very small amount. But if it were not for this, the entire purpose of graftage would be lost.

In the case of dwarfed stock the cause is more mechanical. The root system of the slow growing plant is incapable of supplying sap as fast as the more rapidly growing top demands, hence a reduction in size. Conversely, the demands of the actively-growing top stimulate the root system to a greater effort, and thus cause an increase in the size of the stock, as in the photographs here shown.

The early bearing habit of dwarfed trees may be explained on the theory that the diminished supply of sap tends to weaken the whole tree. Now the object of every plant, one may say, is to reproduce its kind; and when it finds itself weakening, it seems to hasten this process of reproduction, in order to make sure that it may leave progeny before it dies. The dwarfed—and weakened—tree thus blossoms and sets fruit before its normal mates; and it is correspondingly shorter lived, due to this weakening, in consequence of the mechanical restriction of the food supply.

Redfield Offer Remains Open

At the request of the council of this Association, Casper L. Redfield has consented to let his offer for data regarding the results of early marriage, stand open for another year, or until December 31, 1915. It will be recalled that when the original offer terminated on December 31, 1914, the council decided that none of the evidence submitted met the stipulations. As the question of early marriage is one of fundamental importance to eugenics, the council felt that a prolongation of the offer might stimulate public interest in the subject and lead others seriously to study it.

EDUCATION AND RACE SUICIDE

Women's Colleges Have Heavy Responsibility for Disappearance of Old American Stock in the United States—Reforms That Are Needed.

Robert J. Sprague

Professor of Economics and Sociology, Massachusetts Agricultural College, Amherst, Mass.

DURING the twenty-five years from 1887-1911 the deaths among the native born population of Massachusetts exceeded the births among the native born parents by an aggregate of 269,918.[1] During the same period the total births in families having foreign born parents exceeded the total of deaths by 526,987.

The native and foreign birth rates within the Commonwealth have been as follows:[2]

	1890	1900	1910
Native birth rate per 1,000 native born population	12.7	11.7	14.9
Birth rate among foreign born parents per 1,000 of foreign born population	38.6	42.6	49.1
Native death rate per 1,000 native born population	19.9	18.7	16.3
Death rate of foreign born per 1,000 of foreign born population	17.5	16.6	15.4

I have no desire to hold up Massachusetts as a horrible example of a State committing race suicide. Conditions may be just as bad in other industrial and commercial populations, but unfortunately other States have not been wise enough to collect adequate data on these points, whereas the Bay State has led off for many years with a most efficient and commendable system of vital statistics.

If this apparent deficit of native births and the surplus of foreign births are true to the facts, and if they should be maintained for a number of generations, the writing on the wall is clear, and he who runs may read the fate of the Anglo-Saxon stock in every activity of Massachusetts life; and if the conditions in this Commonwealth are typical of American industrial populations generally, then it is a National as well as a local problem that faces us.

How many children must each child-bearing woman, on the average, bring forth in order to sustain the present population, not providing for any increase?

Let us start with 200 living babies of native stock, of which 103 will on the average be boys and ninety-seven girls, due to the fact that nearly 6 per cent. more boys than girls are born. By the time the girls become twenty years of age at least nineteen will have died, leaving seventy-eight as possible wives.

It is a little uncertain to say how many of this seventy-eight would not marry, but I have a few data from which to get a general estimate.

In a selected New England village in 1890 there were forty marriageable girls between the ages of 20 and 35. Today thirty-two of these are married, 20 per cent. are spinsters.

An investigation of 260 families of the Massachusetts Agricultural College students shows that out of 832 women over 40 years of age 755 or 91 per cent. have married, leaving only 9 per cent. of spinsters. This and other observations indicate that the daughters of farmers marry more generally than those of some other classes.

In sixty-nine (reporting) families represented by the freshman class of Amherst College (1914) there are 229 mothers and aunts over 40 years of

[1] These aggregates are computed from the annual reports of "Births, Deaths and Marriages" issued by the Secretary of State.

[2] These statistics are computed from the U. S. Census Reports.

age, of whom 186 or 81 per cent. have already married.

It would seem safe to conclude that about 15 per cent. of native women in our general American society do not marry during the child bearing period. Deducting 15 per cent. from the seventy-eight possible wives leaves sixty-six probable wives. Now among the native wives of Massachusetts 20 per cent. do not produce children, and deducting these thirteen childless ones from the sixty-six probable wives leaves fifty-three probable, married, child-bearing women, whose duty it is to reproduce the original 200 individuals with which we began this study, or an average of 3.7 children for every married woman who demonstrates any ability to bear offspring.

According to these probabilities, every married woman bearing children must bring three to maturity, or to a marriageable age, in order to prevent the race from actually declining in numbers.

Under the present practices this would seem to be the minimum, because no account has been taken of those who are not marriageable on account of insanity and other incapacitating troubles.

THE SCHOOLS AND RACE SUICIDE.

The causes of race suicide in some parts of America are "numberless as the sands on the seashore," but I will discuss at length only the relation of higher education to it.

Too small a birth rate leads to race extinction, and too great a birth rate is the next greatest folly, since it may precipitate not only a domestic but a world problem. The great German birth rate is the natural force behind the present war. Too large a family is liable to cripple and stunt the higher life of both parents and children, and too small a one leads to lack of virility in both individuals and race.

The attitude of the schools towards the interests of the race merely reflects the general ideals and feelings of society and the immediate managers of these institutions should not be held unduly responsible for the failure of the schools and colleges in the past to prepare the new generations for their living needs and racial responsibilities.

Until recently the high schools of the whole country turned their backs on the family and failed to recognize the vital interests of this most fundamental institution; they tried to prepare our children for college, for the parlor, club and travel, but did not recognize the demands of the workshop, kitchen and nursery where the greater part of the average parent's time and energy must be spent. First in reform came the introduction into education of office work, and finally will come the preparation for the revitalized home life and race survival.

The former old public school ideals of the white collar, the white dress and helpless hands have sent thousands of boys into hopeless bachelor jobs and just as many girls into sterile school teaching and other nice, clean occupations where their blood might dry out of the race.

The former lack of opportunity in America for universal, efficient, vocational education has filled our roads with tramps, our prisons with young men, our brothels with young women, and the poorhouses with the aged of both sexes. These things, however, are changing in the public schools all over the land, and the common cry is to bring the school system down to the needs of actual life, earning power and efficiency in shop and home.

Home making and child rearing is the greatest job of life and calls for every resource of brain, hand and heart; anything which detracts from their normal development is an evil, because nothing can substitute for them in importance.

THE WOMEN'S COLLEGES.

The classical college education for women without any doubt develops a high type of character and independence in the graduates as individuals, and such a training might be desirable for all girls that can afford it, if certain vital interests of the race and its future were taken into account. The standards of the home, school and office are all elevated when college graduates

enter them, but how about the vital future of the race?

Is the woman's college as now conducted a force which acts for or against the survival of the race which patronizes it? Whatever intellectual and moral superiority a race may have, it needs also a certain amount of reproductive impulse in order to remain on the earth. No culture, art, science or morality can save it unless it produces about three matured children per married, child-bearing couple, and any race which does not do this is doomed to extinction. If we have forces which are drawing off the best blood of the American stock and sinking it in a dry desert of sterile intellectuality and paralytic culture, let us know the facts, and let these magnificent colleges face them and the race responsibilities involved, because without any doubt, all of our great educational institutions can and will become powerful agencies for race survival rather than race suicide when their wealth and influence become applied along the right lines. The work to be done is not a criticism and reform of the colleges alone, but a change in the ideals and race feelings of the types of people that are represented in these institutions.

Reliable statistics can be obtained from only a few of the institutions granting college degrees to women. Those mentioned below have collected data concerning their alumnae and have made them accessible for the purposes of this paper.

It would be interesting to compare the effects of the education of women in the great coeducational institutions with the results tabulated below from the exclusive women's colleges; but no data are available for such a comparison. Either the coeducational institutions have given no attention to the matter, or they are too young for their results and tendencies to be discernible.

MT. HOLYOKE COLLEGE.

Mt. Holyoke College, the oldest great college for the higher education of women in this country, has collected some interesting statistics on the marital tendencies of its graduates.[3]

Decade of Graduation	Per Cent. Remaining Single	Per Cent. marrying	Children per Married Graduate	Children per Graduate
1842—1849	14.6	85.4	2.77	2.37
1850—1859	24.5	75.5	3.38	2.55
1860—1869	39.1	60.9	2.64	1.60
1870—1879	40.6	59.4	2.75	1.63
1880—1889	42.4	57.6	2.54	1.46
1890—1892	50.0	50.0	1.91	0.95

Professor Hewes estimates from these facts that 41.9 per cent. of Mt. Holyoke graduates ultimately marry.

BRYN MAWR COLLEGE.

From 1888 to 1900 Bryn Mawr graduated 376 alumnae and up to January 1, 1913,[4] 165 or 43.9 per cent. of these had married. Up to that date these alumnae had given birth to 138 children, or an average of .84 of a child per married alumna, or .37 of a child per graduate in all classes up to 1900. Only 32.8 per cent. of all graduates up to January 1, 1913, had married up to that date.

VASSAR COLLEGE.

A compilation of the data given in the "Fourth General Catalogue of the Officers and Graduates of Vassar College" yields the following aggregates and percentages.

[3] Published by Prof. Amy Hewes of Mt. Holyoke College in the reports of the American Statistical Association.

[4] See "Statistics of Bachelors of Arts of Bryn Mawr College," published by the Administration.

CLASSES FROM 1867 TO 1892.

Number of graduates	959
Number that taught	431 (45 per cent).
Number that married	509 (53 per cent. of all graduates).
Number that did not marry	450 (47 per cent).
Number that taught and afterward married	166 (39 per cent. of all who taught).
Number that taught, married and had children	112 (67 per cent. of all who taught and married).
Number that taught, married and were childless	54 (33 per cent).
Number of children of those who taught and had children	287 (1.73 children per family).
Number of children of those who married but did not teach	686 (2 per married graduate that did not teach).
Total number of children of all graduates	973 (1 child per graduate).
Average number of children per married graduate	1.91
Average number of children per graduate	1.0

CLASSES FROM 1867 TO 1900.

Number of graduates	1739
Number that taught	800 (46 per cent).
Number that married	854 (49 per cent).
Number that did not marry	885 (51 per cent).
Number that taught and afterward married	294 (31 per cent).
Number that taught, married and had children	203 (69 per cent. of all who taught and married).
Number that taught, married and were childless	91 (31 per cent).
Number of children of those who taught and had children	463 (1.57 children per family).
Number of children of those who married but did not teach	1025 (2 each).
Total number of children of all graduates	1488 (.8 child per graduate).
Average number of children per married graduate	1.74 per married graduate.
Average number of children per graduate	0.8

WELLESLEY COLLEGE

The data concerning Wellesley graduates are not as complete as might be desired, but Miss Caswell, the Secretary to the President, reports the following statistics.

Classes	Number of Alumnae	Number Married	Per Cent. Married	Number of Children	Number of Children per Married Graduate	Children per Graduate
1875–1889	528	265	50%	438	1.65	.83
1890–1912	3927	1213	31%	1287	1.06	.33
Total	4455	1478	33%	1725	1.17	.39

Women are the capital of the race. The farmer that uses his land for golf links and deer preserves instead of for crops has but one agricultural fate; so the civilization that uses its women for stenographers, clerks and school teachers, instead of mothers, has but one racial fate.

A FEW PERTINENT POINTS.

The space given to this paper is not sufficient for much discussion of the causes of and remedies for the situation presented by these statistics, and it might not be well to enter into that anyway; but I will mention a few points that seem important.

1. There is needed throughout the nation a campaign of public education through church, school, and legislation, to strengthen the ideals and economic foundations of the family. Our education has glorified individualism and our tax system has steadily penalized the man with a family. The opportunities for social legislation in laying a better foundation for the family and ultimately the race are unlimited. Such a development would be reflected in the new aims

and methods of schools and colleges. Public opinion must be created by our leaders of literature and thought both without and within the educational institutions, and it is high time that this line of action is pushed to results, before the best blood of the American people becomes dried out of the race.

2. More strong men are needed on the staffs of public schools and women's colleges, and in all of these institutions more married instructors of both sexes are desirable. The catalogue of one of the colleges referred to above shows 114 professors and instructors, of whom 100 are women, of whom only two have ever married. Is it to be expected that the curriculum created by such a staff would idealize and prepare for the family and home life as the greatest work of the world and the highest goal of woman, and teach race survival as a patriotic duty? Or, would it be expected that these bachelor staffs would glorify the independent vocation and life for women and create employment bureaus to enable their graduates to get into the offices, schools and other lucrative jobs? The latter seems to be what occurs.

3. Some people are advocating coeducation as a solution of these difficulties, but we cannot now make assured statements on that matter, because there are not sufficient data available for final conclusions, and time only can show the effects of the coeducational institutions of the other parts of the country. If by coeducation we merely enable the women to get a man's education and prepare for a man's work, then certainly this is not a full solution, even though the environment of college life would be more normal and lead to some marriages.

4. Women college graduates are not greatly sought after as mates, to share in the work of getting a living and founding a family, because they are not prepared psychologically and technically for the jobs of cooking, sanitation, nursing and child rearing, and are not seeking that mode of life except under specially selected conditions. They have culture and intelligence and demand high standards in husbands and homes, but they are not prizes in the matter of efficiency in domestic life. The principles of supply and demand are effective in this as in other things. If college women could combine their culture with domestic ideals and efficiency there would be a higher demand for them as helpmeets and mothers of the new generation. The American people as a whole have idealized individual independence in both men and women, instead of the family which must be the fundamental basis of race survival, and as long as we maintain that attitude our race suicide statistics will be portentous.

Lectures in Eugenics

At the request of the Young Men's Christian Association of Washington, the American Genetic Association arranged a course of public lectures on eugenics which has been largely attended. The speakers secured were the following: Feb. 4, Alexander Graham Bell on Heredity and Marriage; Feb. 11, Paul Popenoe on the History of the Eugenics Movement; Feb. 18, Dr. L. E. Cofer, assistant surgeon general, U. S. Public Health Service, on the Relation of Immigration to Eugenics; Feb. 25, G. N. Collins, Bureau of Plant Industry, on How Heredity is Measured; March 4, Roswell H. Johnson, University of Pittsburgh, on the Young Man and Marriage; March 11, Alexander Johnson, the Training School, Vineland, N. J., on Feeblemindedness; March 18, Dr. Elnora Folkmar on Negative Eugenics and Racial Poisons; March 25, Paul Popenoe on Heredity vs. Environment; April 1, Paul Popenoe on the Birth Rate; April 8, Daniel Folkmar of the Bureau of the Census on the Evolution of Man.

A DENT IN THE FOREHEAD

Charles B. Davenport

ONE of the most striking phenomena to a student of heredity is the definiteness with which certain small, apparently insignificant, peculiarities are inherited. This is very prettily illustrated again by a case which a correspondent has sent to me and, although the family history is only a fragment, it is so instructive as to be worth publishing.

The trait in question consists of a small depression in the sagittal plane of the frontal bone, extending two or three centimeters above a line joining the upper limits of the orbits. The depression is a striking one, but the morphological changes involved do not seem to be great. Nevertheless they are very persistent in the family history and without doubt indicate a definite modification of the germ plasm which is, in accordance with the modern interpretation, of the positive, dominant sort; that is, due to the addition of a gene.

We start with a fraternity of three grown children, born between 1885 and 1890 (III, 20-23). The first, a male, has a deep dent in his forehead, as if his skull were pushed in. This is the young man whose photograph is presented herewith (Fig. 6). The second, male, has a deep crease or dent in forehead and the third, female, has a crease in forehead. A fourth member of the fraternity was a small boy who died at the age of nine months and of whom we have no description. The *father* of this fraternity of three (II, 15) had a dent in the forehead. The *mother* (II, 14) was unrelated to the father and none of her relatives had a peculiarity of this sort. By another wife the father had one daughter (III, 24) who, likewise, had the crease in the forehead. As this other wife was unrelated and did not show the crease in the forehead, this portion of the pedigree, alone, is sufficient to suggest strongly that the positive trait is carried in the germ plasm of the father.

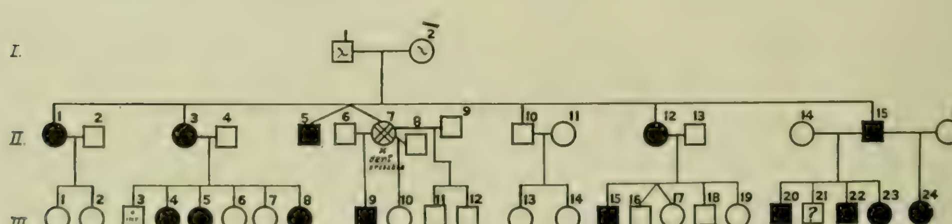
The father was one of a fraternity of seven, three males and four females. One of his brothers (II, 5) showed the same crease in the forehead. The other did not. Three of the sisters certainly have shown the crease in the forehead. One of these is married and had six children, one boy and five girls, and of these girls three show the crease in the forehead (III, 3-8). Of the fourth sister of the father, long since dead (III, 7), there are no precise data. In response to an inquiry my correspondent has examined a group photograph in which the sister appears and replies: "It is impossible to be sure, but I think there was a slight trace of it from what I could see." This fourth sister has had four children (by three husbands), and one (a son) shows the crease in the forehead. The single member of the second generation who lacks the family trait has two children, neither of whom has the trait; however, the same is true of the two children of his sister (II, 1) who has the trait. Unfortunately definite knowledge is extant concerning two generations only. The conditions in the grandparents are unknown. So far, then, as our information goes it indicates that this slight family peculiarity in the form of the frontal bone of the skull is inherited as a dominant trait.

In conclusion the writer wishes first to thank Miss Rose M. Dawson for her coöperation and, second, to request those in whose family such (or other clearly marked) peculiarity in the form of the skull, appears, or who know of such a family trait among their acquaintances, to communicate the fact to him.

Carnegie Institution of Washington, Station for Experimental Evolution, Cold Spring Harbor, Long Island, N. Y., Jan. 30, 1915.

A HERITABLE DENT IN THE FOREHEAD

This young man is shown as III, 20, in the pedigree chart below. The dent in his skull is located in the median line of the forehead, at the upper end of the frown, and because of the illumination is much less conspicuous in the photograph than in real life. From a photograph copyrighted by Brown and Dawson. (Fig. 6.)



PEDIGREE CHART OF THE X FAMILY

Distribution of the dent or depression in the forehead is here shown in graphic form. Squares represent males and circles females; black symbols designate individuals who show the trait in question; x implies unknown; the abbreviation *d.inf.* means "died in infancy." Some doubt exists as to whether individual No. 7 in generation II showed the trait or not. (Fig. 7.)

HEREDITY OF WHITE FORE-LOCK

Blaze in the Hair Transmitted Through Many Generations—Appears to Behave as Simple Dominant and to Follow Mendelian Proportions—History of an American Case.

Newton Miller

Professor of Biology, Wheaton College, Norton, Mass.

ALBINISM in man has been frequently recorded during the last two centuries, but it is only comparatively recent that data have been collected with the object of explaining its behavior in inheritance. A glance at the excellent monograph by Pearson, Nettleship and Usher shows that albinism may appear in almost any degree from a mere colorless spot to a complete lack of pigment in hair, skin and eyes. The former is the condition with which we are at present concerned.

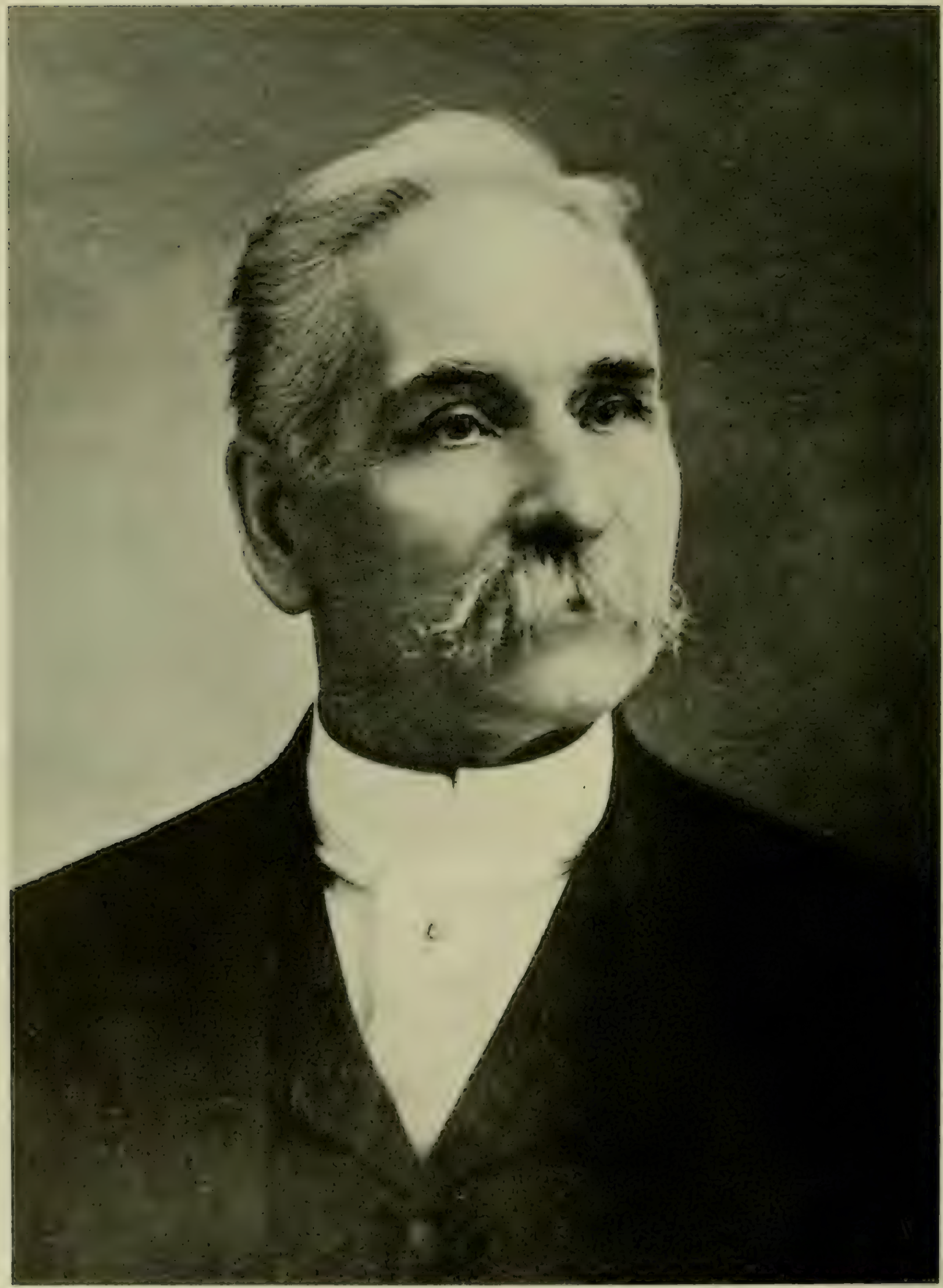
Rizzoli published in 1877 a record showing a fore-lock of white hair running through six generations of a family comprising 49 individuals in the direct line of descent. A similar account by Harman appeared in 1909. In Harman's case the "flare" cropped out in six successive generations of a family numbering 138 members in the direct line. Other colorless patches are said to be found on various parts of the body in this family. Three years later Cane referred to a family of 42 individuals with a white frontal lock appearing in each of the four generations mentioned. The pedigree which I offer is in many respects a duplicate of those cited above.

I am indebted to Miss Agnes Joynes (IV. 38), a member of the family, for the active part she has taken in the collection of the data for this study and to her is due the greater credit for the record.

In the year 1821 a Mr. Little with his three daughters immigrated to America from Carlisle, England, and settled on a branch of the St. John river in New Brunswick, Canada. His only son, Dr. William Bell Little (II. 3), followed two or three years later and made his home also in New Brunswick. It is in the descendents of Dr. Little that the white lock may be found in the American branch. The family traces its origin back through the Percys, Mortimers, even to Edward III. We are interested in the family of Harry "Hot-Spur" Percy for here, according to a current story, originated the white lock. Harry "Hot-Spur" in a rebellion against Henry IV. was killed in the battle of Shrewsbury, 1403. When the news of his death reached his pregnant wife, she swooned, pressing her hands to her forehead as she did so. The son born a few hours later bore a white patch on his forehead corresponding to the spot touched by Lady Percy as she swooned. The mark has since appeared in some members of each and every generation of this child's descendants. Dr. Spurgeon Jenkins (IV. 4) has suggested the direction in which explanation should rather be sought. While in England he looked up his antecedents and found to his satisfaction that the colorless patch goes back to the Percys, but he found also that Lady Percy was an albino. This of course is no explanation, since there is no record of an albino giving rise to spotted individuals or spotted to albinos.

LOCATION OF THE LOCK.

The white lock located on a white patch of skin on or near the median line of the forehead and crown in the American family stands out prominently in contrast to the black or brown hair adjoining. In addition, other colorless spots are to be found on the bodies of some of the individuals possessing the "flare." The mother of V. 18 describes her son thus—"a white heart-shaped spot on the forehead just

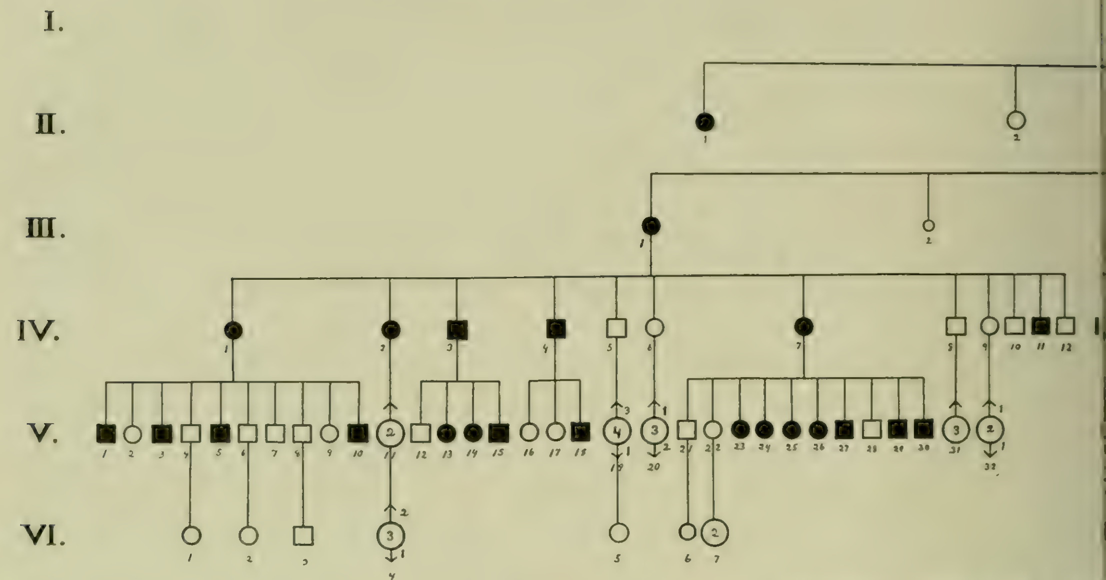


AN EARLY POSSESSOR OF THE LOCK

This man is designated in the pedigree chart (Fig. 10) as III, 10, and is therefore a son of the Dr. Little who brought the trait to America. He passed it on to his son, with whom this line stopped. In the family, however, it is definitely charted for six generations, and at least two other families have been studied where the trait has been traced for six generations, while in many cases a similar lock has been followed through several generations until lack of data forced the investigator to abandon his quest. (Fig. 8.)

THE WHITE LOCK, SPREAD OUT

This girl, V. 14 in the pedigree chart (Fig. 10), is a sister of the girl shown in the frontispiece. There were two brothers and two sisters in this family; both sisters and one brother had the white lock which, on the average, has characterized half the stock in which it is running. (Fig. 9.)



DESCENDANTS OF DR. WI

Dr. Little, a resident of Carlisle, England, and a descendant of the famous Percy family, emigrated to Ame hair, and has passed this on to a large number of his descendants. The above pedigree chart shows that the individual was marked by the white lock of hair. For the sake of conciseness, large symbo indicates the number of children in the fraternity, a smaller numeral above showing the number who w matings has not been shown, since they were all with unaffected individuals. Thus when a parent ha one not possessing it (recessive), or in genetic notation a DR mating, while when the symbol is white between two who did not carry the trait; in such cases, the trait could never reappear in their descendan

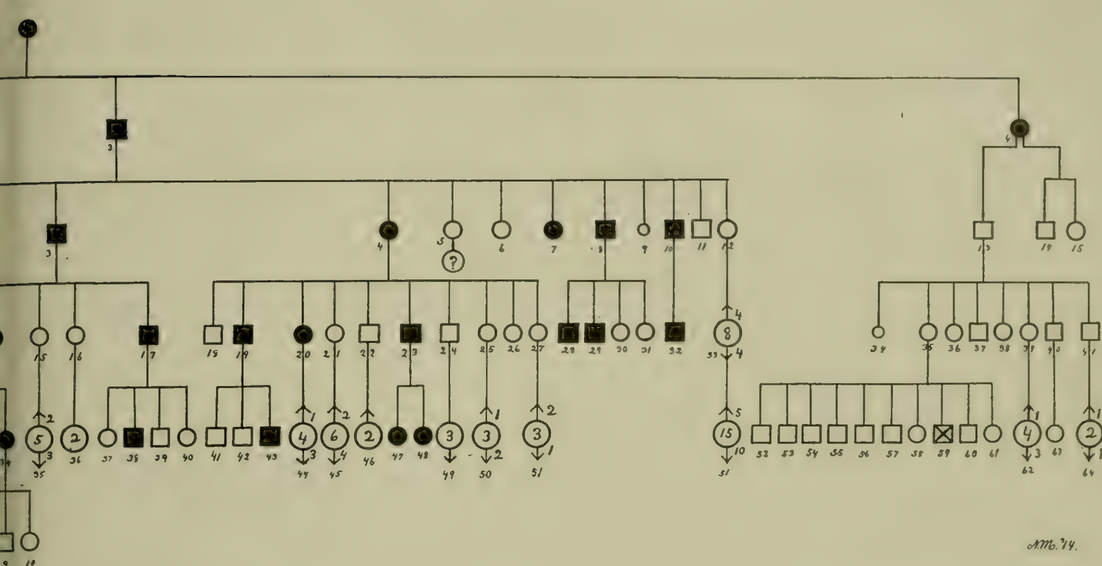
below the white lock of hair, a white heart-shaped spot on the right knee with a ribbon running down the leg and encircling the ankle, and a white mark on the abdomen."

Lad (V. 59) now 12 years of age had in his early childhood a patch of yellowish hair on the back part of his head. At this time, however, its color has changed completely to that of the rest of his hair.

The accompanying chart represents 203 individuals of whom we have accurate information. All are blood related. Only one consanguineous marriage has been contracted, that of a son of III. 5 and the third daughter of III. 12. Both families of III. 5 and III. 12 are free of the mark and the four children of the cousin marriage are also.

An examination of the chart shows that the white lock crops out only in those families one parent of which is thus marked. It is further seen that the lock behaves as a simple dominant with normality as recessive. Consequently two types of matings are represented, *i. e.*, DR x RR and RR x RR, the individuals with the frontal patch being hybrids (DR) and the others (RR) pure recessives. Theoretically we should expect to find the leucotic spot in one-half of the children in families where one parent is marked, and not at all in children of unmarked parents. These expectations are fairly well borne out by the actual data which give for the former 45 with, to 51 without the "flare," and for the latter, none.

The above statements apply equally well to the cases of Rizzoli, Harman and Cane. These pedigrees give the proportions of those with, to those without the albinic lock as 17 to 15, 23 to 15 and 23 to 13, respectively. Combining the data at hand we obtain the interesting result of 108 with the white lock and 94 without. Thus the conclusion seems warranted that the white lock is a simple dominant and that it follows closely the Mendelian law.



AM BELL LITTLE (II. 3)

about 1824 and settled in New Brunswick. He had inherited from his mother a congenital white lock of members of the family, squares representing men and circles women. When the symbol is black, it indicates nclosing a number have been used to designate several fraternities of unaffected individuals; the number boys and a similar numeral below those who were girls. Further for the sake of brevity, the exact nature of the black symbol, it is to be understood that the mating was between a person possessing the lock (dominant) and neans that an unaffected, or recessive, person married a similar person, the mating (RR) therefore being (Fig. 10.)

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Breeding Hardy Winter Barley

Until now, winter barley has not been a success north of the Ohio river, as all previously existing varieties were killed by hard winters. The Michigan Experiment Station has three winter barleys that successfully passed the severe winter of 1911–12 and one of these is being increased at the Upper Peninsula Station at Chatham. It has done well there, and this fact seems to indicate that these varieties may extend the winter barley belt to Lake Superior.

The two winter barleys that were increased at East Lansing in 1914 were ripe on June 24, or three weeks earlier than the earliest spring barley. During the seasons of 1913–14, these two strains have averaged 55.4 bushels. The average production of barley in Michigan is set at 25 bushels by the U. S. Department of Agriculture. If generally grown, these winter barleys may double the average yield of barley in the state. Compared with oats on the basis of pounds of grain per acre, 55.4 bushels of barley equals 83.1 bushels of oats.

EUGENICS AND IMMIGRATION

Large Amount of Bad Breeding Prevented by Medical Examination of Aliens at Ports of Entry—Detection of Defectives More Thorough Now Than Ever Before, Because of Decrease in Numbers Arriving.[1]

Dr. L. E. Cofer

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THE word "Eugenics" has appeared in literature only within the last ten years. It may be defined in a few words as a science which attempts to improve the physical development and mental equipment of the individual in so far as this may be possible by heredity. The attempt to improve human stocks of all kinds during recent years has taken form, so far as it relates to immigration, in preventing unfit persons from coming into the country, either by being born into it or by being brought into it by migration.

In the same sense the execution, incarceration or asexualization of criminals, or the segregation of certain other classes—paupers, insane persons, idiots, lepers and the like—tend to raise the quality of the human stock.

Properly speaking, however, eugenics does not include so much the prevention of the production of unfit, as it does the attempt to produce the more fit. On stock farms all over our country, in private stables and in kennels men are spending their lives in the improvement of our breeds of horses, cattle, sheep, dogs and swine. By selective breeding it is quite possible to breed cows which will yield about 12 gallons of milk per day, which means that a 1400 pound cow will yield her own weight every two weeks. We exercise similar care and thought in the development of our grains, vegetables and fruits. Every effort is being made to produce and perpetuate those forms which come the nearest to meeting our ideal. It is therefore probably a just charge that we are more careful of the breed of our horses and dogs than of our children. A natural question would be, then, why is it that with all our efforts to improve the breed of domestic animals, we have neglected the breed of the most important of them all, that is, the human animal? Why have we left the breed of men altogether to chance? We are beginning to ask ourselves these questions, and we are beginning slowly to realize that if society had done its full eugenic duty many a long line of defectives and criminal descendants of defectives would never have been born. It is claimed by many people that we are doing everything we can to encourage the production of defectives, degenerate and delinquent persons by the way in which we feed and clothe them, by the way in which we increase the annual sums for asylums, almshouses, prisons, hospitals, etc., in which we can confine our insane, paupers, habitual criminals, and imbeciles, leaving them free, during a part of their lives, in any event, to propagate their kind, and it has been shown that this class of persons, if given opportunity, is relatively more prolific than the better and more useful class of citizens.

THE IDEAL OF EUGENICS.

And thus we come to ask why we can not breed the superman, or in other words we are discussing the artificial breeding of mankind itself. Unfortunately the average advocate of eugenics as applied to man is apt to consider the production of superman bodies paramount to the production of superman

[1] Address delivered before the Young Men's Christian Association of Washington, D. C., February 18, 1915.

minds, superman character, or persons with superman souls. That is to say, the superman who will be assembled for the purpose of leading a strenuous life to improve the world is the one whom many of us have in mind especially if we read Bernard Shaw.

Really the production of an evenly balanced, conservative, intelligent and healthy individual should be the aim of eugenics, and not the raising up of a monstrosity or curiosity in human life.

In the eighteenth and nineteenth centuries, Europe attempted to improve its race stocks by the deportation of the less desirable individuals. Each country had its penal colonies, and in addition used the United States as a dumping ground for its convicts, paupers and insane. The immigration laws of the United States, which purport to exclude some twenty-one classes of mentally, physically, morally and economically undesirable persons, were originally intended to protect the country from the dumping process above described. But, inasmuch as they operate equally in the cases of assisted and of normal immigration, they really go further than this; and, so far as they are enforced, tend to eugenic results by selecting the better classes of aliens for the fathers and mothers of future citizens.

This brings us to the consideration of immigration in its general sense. The migration of men or other animals is caused almost entirely by the universal search for food. Man, like every other organism, spreads all over the earth in search of a living, and when he finds himself in a locality able to support him, he is usually willing to remain there. It will usually be found, therefore, that the average immigrant's reason for shifting his residence from some other country to this country is the relative over-population of his native country. The term "over-population" is given to a place which contains more people than can be fed with food raised in that country. The word "over-population," however, has been discarded and the word "saturation" has replaced it, for the reason that it is easier to think of the migrations of the peoples of the world as fluid-like migrations, on the general principle that water always seeks its level, and that a sponge more than saturated will begin to drip. Therefore, a locality overcrowded with inhabitants is not unlike a soil which cannot possibly hold all the rain which is poured on to it. Some must run off or be evaporated after collecting in pools. The overpopulated or saturated place is one which cannot hold the rain of babies poured upon it. They too collect in pools of humanity to be evaporated in pools of death, or they must flow off in streams in one direction or another, and these streams are the streams of migration, which when they converge at the shores of our country are termed by us our streams of immigration.

THE STREAM OF IMMIGRANTS.

Now let us see what these streams of immigration mean to the United States. During the fiscal year ended June 30, 1914, 1,485,957 immigrants landed on our shores; the year before that 1,574,-371 landed; the year before that 1,143,-234 landed; the total for the last six years being 7,544,452. In other words, considerably more than 1,000,000 persons a year from other countries have migrated to our shores during the last six years. These immigrants comprised Africans, Armenians, Bohemians, Moravians, Bulgarians, Servians, Montenegrins, Chinese, Croatians, Slavonians, Cubans, Dalmatians, Bosnians, Dutch, Flemish, East Indians, English, Finnish, French, Germans, Greeks, Hebrews, Northern and Southern Italians, Japanese, Lithuanians, Magyars, Mexicans, Poles, Portugese, Roumanians, Russians, Ruthenians, Scandinavians (who comprise Norwegians, Danes and Swedes), Scotch, Slovaks, Spanish, Spanish Americans, Syrians, Turks, and West Indians.

These immigrants enter the United States through 88 different places, which places include 25 different ports, and they embark for the United States from 25 different foreign ports. Exclusive of the number of railway lines continuously bringing immigrants over our borders, over 100 steamship companies were occupied, prior to the

beginning of the European war, in the immigrant-carrying trade, and on account of the fact that certain steamship lines had vessels arriving at from two to five different ports, it was found that there were about 173 lines of immigrant travel into this country.

It must not be supposed that these million or more immigrants are allowed to enter the country just as any of us might go from here to New York. On the contrary they are subjected to a series of examinations tending to the elimination, in the first place, of paupers and criminals, and secondly, to the elimination of persons with physical and mental defects. At every port or place in the United States where immigrants arrive, the United States Immigration Service, under the Department of Labor, has officers stationed for the examination of immigrants, to insure compliance with the immigration law, exclusive of matters relating to the physical and mental condition of aliens, which is in charge of the U. S. Public Health Service, under the Treasury Department. This latter Service has medical officers at all the ports of entry, who subject the immigrants to a careful medical examination.

DEFECTS EXCLUDED.

The number of immigrants examined by these medical officers varies from one a year at the port of Aguadilla, P. R., to 1,009,000 at the port of New York. The following classes of aliens are excluded from admission into the United States: Idiots, imbeciles, feeble-minded persons, epileptics, insane persons, persons who have been insane within five years previous; persons who have had two or more attacks of insanity at any time previously; paupers, persons likely to become a public charge; professional beggars, persons afflicted with tuberculosis or with a loathsome or dangerous contagious disease; persons not comprehended within any of the foregoing excluded classes who are found to be and are certified by the examining surgeon as being mentally or physically defective, such mental or physical defect being of a nature which may affect the ability of such alien to earn a living.

In order that the provisions of this law may be put into convenient form for the use and guidance of the medical examiners of aliens, the Public Health Service has issued a book entitled "Book of Instructions for the Medical Inspection of Aliens." In this book the diseases are placed under four headings as follows: Class A-1, Class A-2, Class B and Class C. Under Class A-1 are included idiocy, imbecility, feeble-mindedness, epilepsy, insanity and tuberculosis. Under Class A-2, which is devoted to loathsome, contagious or dangerously contagious diseases, are included favus, ringworm of scalp, sycosis barbae, actinomycosis, blastomycosis, frambesia, mycetoma, leprosy and venereal diseases, such as demonstrable syphilis in an active, communicable stage, gonorrhea and soft chancre. Dangerous contagious diseases include trachoma, filariasis, uncinariasis (hookworm), amebic infection and endemic hematuria. Under class B are included those defects or diseases which affect the ability on the part of the immigrant to earn a living. From the very nature of the diseases included under this subdivision it is apparent that it is impossible to name all of them, but a few are as follows: hernia, the various varieties of heart disease, states of permanently defective nutrition and of marked defective skeletal and muscular development, cases of chronic arthritis and myositis, the various nervous affections, malignant new growths, deformities, varicose veins, senility, defective eyesight, various cutaneous affections, anemia, eruptive fevers, and such tuberculous affections as lupus, Potts disease, hipjoint disease, chronic inflammation of the lymph glands, chronic arthritis of knee joint; in fact, all those diseases of a more or less permanent character which call for institutional care and treatment are included under Class B. Under this heading are given cases of diseased, deformed or crippled children who will require unusual care during childhood, and who are likely to be physically defective if they live to reach maturity. Under Class C come defective or

diseased conditions which do not present in the opinion of the medical examiner requirements for certification under Classes A and B. In other words, Class C is intended to make a complete check as to the physical status of an immigrant. For instance, if an immigrant is found to be perfectly sound with the exception of the absence of two fingers on his left hand, the condition would be considered a reportable one, but not a deportable one.

WORK IS ONEROUS.

Now a word as to what it means to examine physically the aliens entering the United States from foreign countries: During the fiscal year just passed 94 officers of the Public Health Service have been assigned exclusively to the work of examining arriving aliens, and in addition to this a number of officers, although detailed to other duty, have given more or less of their time to the work under consideration.

The results of this examination, which constitutes the practice of eugenics in connection with immigration, are as follows: In the fiscal year just passed, of the 1,485,957 aliens arriving, a total of 41,250 were certified for all causes, of which 3,051 were for trachoma alone; 184 for tuberculosis; 1,040 for syphilis; 157 for gonorrhea and 1,360 for mental deficiency of various kinds. During the last six years, of the 7,544,452 immigrants arriving, a total of 179,557 have been certified, of which 15,971 were certified for trachoma (a dangerous, contagious eye disease); 1,408 for tuberculosis; 1,537 for syphilis; 924 for gonorrhea, and 3,788 for mental deficiency of various kinds.

It is evident that eugenics along the lines above mentioned does not attempt directly to produce the more fit, but it does actually prevent the entry of an enormous percentage of the unfit, as will be seen by the following statistics. The reports of immigrants arriving during the fiscal year ending June 30, 1914, show that of the total number, 1,485,957, there were 313,475 women between the ages of 14 and 44, and that there were 668,217 males between these ages. Statistics also show that the percentage of childless women among immigrants is never higher than 20% in some nationalities, and is as low as 2.5% in other nationalities; also that the child-bearing immigrant women bear from 2.4 to 5.5 children, the average being about 4 children for each child-bearing woman. It is furthermore a general rule that women in the rural communities bear more children than the women in the cities. If from the total number of women arriving in the last fiscal year 20% is deducted as non-child-bearing (which, while by no means fair and accurate for the purpose under consideration, will all the more show the value of our eugenic work) 250,780 women will be left who, according to statistics, will bear an average of four children each, making a total of about 1,000,000 children destined to be born from the immigrant women arriving last year.

It will be seen that by the rejection alone of the 1,360 mental defectives last year an enormous amount of good has been done in preventing births amongst this class of persons. The same may be said in regard to the prevention of propagation amongst the immigrants rejected for the other diseases mentioned, most of which have a distinct tendency towards producing inferiority in offspring. It is manifestly impossible to determine the good results of this examination, and therefore its eugenic value to the country, but there are some facts which will show that the medical examination of immigrants and the rejection of the physical and mental defectives is producing invaluable results. For example, no satisfactory evidence has yet been produced to show that immigration has resulted in an increase in crime disproportionate to the increase in adult population. Such comparable statistics of crime and population as it has been possible to obtain indicate that immigrants are less prone to commit crime than are native Americans, a fact which is a distinct tribute to the good work being done by the immigration officers along the line of preventing to a great extent the landing of immigrants from the criminal classes.

In this connection, however, it is interesting to note that statistics indicate that the American born children of immigrants exceed the children of natives in relative amount of crime. It also appears from data bearing on the volume of crime that juvenile delinquency is more common among immigrants than it is among Americans. There are, however, two factors affecting these conclusions. First, immigrants are found in greater proportion in cities than in rural communities, and the criminality of the children of immigrants is largely a product of the city. Second, the majority of the juvenile delinquents are found in the North Atlantic states, where immigrants form a larger proportion of the population than in any other section of the country.

EFFECTS OF THE WAR.

Just what the eugenic result of the medical examination of aliens has been during the last five years is not known for the reason that census statistics along these lines are lacking. The European war, however, has divided the observation periods, so far as the results of the medical examination of aliens is concerned, into three parts, the first part ending with the commencement of the European war, and with the almost shutting down of immigration from Europe. The second period we are passing through at the present time; that is, the period of duration of the war. The third period will begin with the ending of the war and the resumption of immigration, which it is predicted will be greater than we have ever before experienced.

As a consequence of the war many undesirable persons are not being admitted to our country. If the war continues for a long time we may expect a gradual decrease in our institutional mental and physical defectives, now being cared for at the expense of states and municipalities, but what will be the result when the war ends? Shall we have an influx of physically and mentally deteriorated men, drawn from among the survivors of the great conflict, and from the non-combatants who are suffering as much from privation as the soldiers are from shot, shell and disease; and what will be the permanent character of the defects which these immigrants will present? Will there be more insanity amongst them, or will they present a larger proportion of syphilitic infection, or both? During the second period, or war period, that is to say, the period through which we are now passing, almost the same number of medical officers of the Public Health Service are engaged in examining aliens as were engaged prior to the commencement of the war, although the number of immigrants arriving is very much diminished at all stations, and in certain places, for example, New York and the large ports generally, the volume of immigration has diminished to one-fourth or one-fifth, so that the quality of the medical examination being given at the present time is much ahead of what it has ever been before. As a consequence statistics at the end of this fiscal year will show a large increase in the percentage of rejections from all causes. If the war lasts a considerable length of time, it will be possible to obtain sufficient data as to the results of the preventive eugenic work which has been accomplished to enable us to make intelligent preparations for meeting the increased demands to be made upon the country when immigration from Europe is again resumed.

Breeding Sugar Beets

The Utah state agricultural experiment station has been breeding sugar beets for increased sugar content for many years. After the first seven years of the experiment, all of the large number of strains tried were discarded except one, the progeny of which is now widely grown. "The manager of our local company," Director E. D. Ball writes, "has just recently made the statement that he could tell to the row in the field where our local seed was used, by the uniform character of the beets, and that the average sugar content was from one to two per cent. higher than that of the best European seed obtainable."

FANCY POINTS vs. UTILITY

Many Animals and Plants Scored for Characters That Are Useless or Even Detrimental to Production—Egg Yield of Fowls Neglected—Need For Revision of Standards.

A. F. Blakeslee

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IT seems not out of place in a magazine devoted to breeding and to the development of characters which are judged in the show room, to say a few words in regard to the points and the standards recognized by the show room judge.

Plants and animals have been domesticated and cultivated for one or both of two main reasons—for the pleasure which their presence gives us or for some useful product which they yield in the form chiefly of food, clothing or labor. The distinction is not absolute, even as the distinction between beauty and utility cannot be absolute, but in general we may distinguish the forms primarily ornamental from those primarily useful. The first are grown as pets, the second for utility. The geranium, the cat, the canary bird and the bantam fowl are pets; the cow, the horse, the laying hen and corn are cultivated for utility. The tomato in our grandmother's garden was cultivated for its ornamental fruit and was a pet. Now it has been moved to the vegetable garden and is grown for utility. Ornamental things may be useful, and the market value of a product is not diminished by the inherent beauty of the producer. As the lowing herd winds slowly o'er the lea, it offers no less interesting a sight to the poet and to the artist if the animals are high milk producers. That they are the best of their kind should in fact heighten his admiration. On the other hand, the perfection of form and color that appeals to the eye may indirectly affect the yield. The pride of the flock or of the field will be most tenderly cared for.

A visible character that has a direct connection with yield may be called a utility point while one that has no such direct connection is called a fancy point. Each may be developed without injury to the other, but the man who aims at but a single target is most likely to reach his mark. Seek ye first the most valuable thing and let other good things be as additions unto you, is good advice for all manner of men. To the practical breeder the most valuable thing is yield. This the show room almost entirely leaves out of consideration either directly or by scoring on a multitude of fancy points that often have at best only a fancied connection with the object for which the breed is supposed to be cultivated. In the score card for dairy cattle no place is left for the quantity or quality of milk which the animal is capable of giving. In the ear of corn attention may be given to the straightness of the rows and the completeness with which the tip of the ear is filled out, but the yield per acre is not recorded. The score card for poultry, of which two are shown in Figure 13, gives ten points each for comb, wings and tail, but no credit is given for the number of eggs a bird has laid. Men have paid high prices for prize-winning hens that have failed to produce eggs after they were taken from the show room.

Attempts in many cases have been made to use characters in the score card that may be indicative of yield. In corn, the filling out of the tip, the size of the ear, the size and compactness of the kernels, are all characters that influence the amount of food substance carried by any individual ear but are not of necessity correlated with the yield per acre. In the experience of the

GOOD AND BAD EGG-PRODUCERS

A pair of White Leghorns in the egg-laying competition at Storrs, Conn. The hen at the left (No. 722) is the best layer among the 400 White Leghorns competing. Up to February 23, she had laid 70 eggs. The hen at the right (No. 723) is from the same pen, but laid only nine eggs during the same period. The good layer has pale beak, pale legs and white ear-lobes, while the poor layer shows yellow in these parts. The Standard of Perfection demands yellow in beak and legs, and the poor layer was scored the higher by the professional poultry judge. But there is reason to believe that an absence of yellow in these parts denotes high egg-capacity and its presence low fecundity; if this is the case, then the Standard and the judges are working directly against high production which, after all, is the purpose of a fowl. Photograph made February 22, 1915. (Fig. 11.)

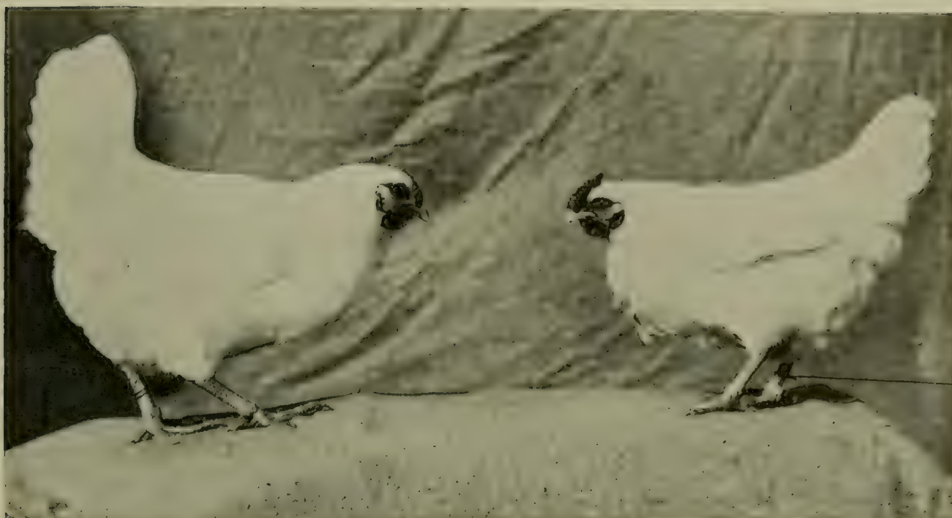
Connecticut Experiment Station, poor scoring strains of corn have been found to out-yield better scoring strains in comparative test cultures.

In dairy cattle, the size and character of the milk veins are apparently considered strongly indicative of the quantity of milk an individual cow can produce. In Jerseys, four points are allowed for milk veins in the score card; in Ayrshires, five; in Guernseys, eight; and in Holsteins, ten. There is no evidence that the value of the milk veins as an index of the flow of milk differs in the breeds mentioned in any direct relation to the actual number of points allowed in the various score cards.

POULTRY STANDARDS.

In poultry probably less attempt is made to use characters in the score card indicative of yield than in most other economic breeds of animals or of plants, and the standards may be so fictitious that they are even directly opposed to the natural development of the animal. As an instance of the latter condition may be mentioned the barring in Plymouth Rocks. Dark and light strains exist in this breed, but in a given strain the males are naturally lighter than the females. Barring is a sex-linked character, and this lighter color of the male is probably due to his having the factors that lighten up the plumage present in a duplex condition. At any rate, the lighter color of the barred male is as natural a condition in the breed mentioned as is the presence of a beard in the male of the human species. In order to win prizes for exhibition pens, however, poultrymen have resorted to so-called double-mating, breeding males from dark strains and females from light strains, since judges give preference to pens in which the males and females are matched in shading. The practice is as logical as to require a man and his wife to match in the amount of hair on the face. In the human species, however, we are assured that we shall be judged for our good deeds and need stand in no fear of fancy points in the score card at the last day of judgment.

Most fancy points probably are indifferent so far as they directly in-



SHOW POINTS OPPOSE PRODUCTION

A pair of White Wyandottes in the Storrs contest. At date of photographing (Dec. 23), the hen at the left (No. 137) had laid no eggs, while the one at the right (No. 132) had laid 34 and was the best layer in the pen. The function of a hen is to lay eggs, and to produce egg-layers should be the object of the breeder. The standards should, therefore, be set up with this object in mind. Yet the poor layer here shown was scored higher than the good layer, 92½ points as compared with 89¼, the good layer being cut, among other reasons, because her beak was faded. The score cards are shown in the following figure. The left-hand bird, which when photographed had yellow beak and yellow legs, had produced only 13 eggs up to February 23, while the bird that shows pale beak and legs had a record of 81 during the same period. (Fig. 12.)

fluence the practice of breeding plants and animals for utility. The danger is that they tend to substitute a fictitious standard for real value and thereby distract the aim of the breeder. In some cases, however, the standards may be in direct opposition to utility. It seems not inappropriate to discuss as an example, a fancy point directly opposed to utility that has come to the writer's attention in connection with an investigation undertaken with D. E. Warner. A preliminary report on the work is presented in *Science*, Mar. 19. It has been found that the yellow pigment in the ear-lobes, the beak and the legs of Leghorn pullets disappears when they begin to lay and returns again when they cease laying. The ear-lobe is apparently most quickly responsive, the beak next and the legs are the last to be affected by a change in the laying activity. Figure 11 is a photograph of two Leghorns which showed a difference in color in the parts mentioned. The good layer had 15 per cent. yellow in her ear-lobes while the poor layer showed 35 per cent. yellow in the same parts. The color of the ear-lobes has been measured by means of a color top, and a high negative correlation established between laying activity and the amount of yellow pigment present. The tables for this are published elsewhere.

The beaks and legs have been roughly graded as pale, medium and yellow. In Table I is shown the percentage of the birds in the different color groups actually found laying on the last of October. If a bird was laying on the day of record she is credited with a zero, if on the day before the record was taken, she is credited with one "day since laying." The yellower the ear-lobes, the beak and the legs, the longer on the average since the last egg was laid. The Wyandottes are a type of fowl that do not show color changes in their ear-lobes, which remain permanently red.

The beak and legs alone in such breeds, however, form a ready means of selecting the laying hen.

PRODUCTION PENALIZED.

The "Standard of Perfection" which controls the judges in the show room demands yellow in the beak and legs of the two types of breeds recorded in Table I. Other things being equal therefore, in preferring the bird with yellow beak and yellow legs, the poultry judge is preferring the poorer layers. That this is not a mere theoretical conclusion is illustrated by Figure 12. The best layer in the pen was scored down because her beak appeared faded. In other fancy points also she was a poor scorer—in fact had the lowest score in her pen. Her score card is shown in Figure 13 alongside that of the highest scoring bird from the same pen. The highest scorer, however, turned out to be the poorest layer in the pen. Their egg records up to Feburary 23rd are shown in Figure 14.

The blanks in Figure 14 show a type of score card that is well nigh ideal. Perfection is judged by production. A bird, or a pen, that wins in such an egg laying contest as the one conducted at Storrs, Conn., is obliged to lay eggs.

TABLE I.

Percentage of Birds Laying, Average Number of Days since Laying and Yearly Totals for Different Color Grades of Beaks and Legs.
(P, M and Y are abbreviations for Pale, Medium and Yellow; the color of beak is written first followed by color of legs.)

WHITE LEGHORNS (256 Birds with yearly average of 150.4 eggs).

	P.P.	M.M.	Y.Y.	P.M.	P.Y.	M.P.	M.Y.	Y.P.	Y.M.
Number of Birds	51	17	97	2	0	25	1	14	49
Average days since laying	6.6	30.4	57.8	30.5	....	20.8	64.0	28.6	45.9
Number Birds laying	32	2	1	0	....	3	0	1	1
Percentage Birds laying	62.8	11.8	1.0	0.0	....	12.0	0.0	7.2	2.0
Yearly averages	186.4	146.4	129.3	150.5	....	178.7	122.0	158.4	139.9

WYANDOTTES (79 Birds with yearly average of 144.8 eggs).

	P.P.	M.M.	Y.Y.	P.M.	P.Y.	M.P.	M.Y.	Y.P.	Y.M.
Number of Birds	28	13	24	1	0	4	0	0	9
Average days since laying	6.5	17.5	48.9	0	....	7	....	....	28.7
Number Birds laying	16	5	0	1	....	2	....	....	1
Percentage Birds laying	57.2	38.5	0.0	100.0	....	50.0	....	....	11.1
Yearly averages	178.3	130.7	108.4	194.0	....	161.5	....	....	145.6

TABLE II.

Yearly Egg Records for Hens Pale (P) in Different Parts. (256 White Leghorns with yearly average of 150.4 eggs.)

Number of Birds	Ear-lobes	Beak	Legs	Yearly Average
90	....	....	Pale	179.9
53	....	Pale	....	185.3
40	10–20% yellow	....	....	189.4
51	....	Pale	Pale	186.4
31	10–20% yellow	Pale	Pale	191.9

EACH SECTION COUNTS 10 POINTS.

Section		Cut
CONDITION WEIGHT OR SIZE		
COMB OR CREST AND COMB		1 1/4
HEAD AND ADJUNCTS	Beak, Eyes, E. Lobes, Wattles	1/4 1/2
NECK	Shape	1
	Color	1/2
BACK	Shape	1 1/2
	Color	1/2
BREAST	Shape	1
	Color	1/2
BODY AND FLUFF	Shape	1/2
	Color	1/2
WINGS	Shape	x
	Color	1/2
TAIL	Shape	1 3/4
	Color	1/2
LEGS AND TOES	Shape, Plumage, Color	
TOTAL DEFECTS		10 3/4

EACH SECTION COUNTS 10 POINTS.

Section		Cut
CONDITION WEIGHT OR SIZE		x
COMB OR CREST AND COMB		1 1/4
HEAD AND ADJUNCTS	Beak, Eyes, E. Lobes, Wattles	x
NECK	Shape	3/4
	Color	1/2
BACK	Shape	x
	Color	1/2
BREAST	Shape	3/4
	Color	1/2
BODY AND FLUFF	Shape	1/4
	Color	1/2
WINGS	Shape	x
	Color	1/2
TAIL	Shape	1 1/2
	Color	1/2
LEGS AND TOES	Shape, Plumage, Color	
TOTAL DEFECTS		7 1/2

ORDINARY TYPE OF POULTRY SCORE CARDS

Essential parts of the score cards of the two White Wyandotte hens shown in Fig. 12. At the left is the list of "cuts" made by the professional judge against No. 132, the good layer, while the cuts made against No. 137, the poor layer, are shown on the right. The fact that the poor layer was scored highest, taken in conjunction with similar cases reported all over the country, indicates that breeders of fancy poultry are inclined to lose sight of the real purpose of breeding fowls, and to fix their attention on merely fancy points instead of on the egg-laying function. (Fig. 13.)

By their fruits are they judged; and although a misplaced feather on a hen's leg may disqualify her from the show room, it does not disqualify her from showing her ability to lay. For this purpose was she brought into the world, and for a well spent life only should she receive a crown of reward. Milk testing associations are rendering to the practical breeder a similar service to that afforded by egg-laying contests, although the length of the tests does not give the best opportunities to judge the real merits of an animal. Such contests, based on production, are obviously more difficult to conduct than those based on mere inspection but are commensurately more valuable.

From what has been said, it is not intended to imply that show room contests should be done away with. They have elements of too great value even to agriculturists for such drastic treatment. It is suggested, however, that the standards be changed and account be taken of yield wherever possible. It

FOURTH ANNUAL INTERNATIONAL EGG LAYING CONTEST
STORRS AGR. EXP. STATION---CONN. AGR. COLLEGE, STORRS, CONN.
NOVEMBER 1, 1914 — OCTOBER 31, 1915

VARIETY "White Wyandottes | RECORD 1ST YEAR | PEN NO. 14
OWNER Tom Barron, | BAND NO. 137
OWNER'S ADDRESS Catforth near Preston, England. | OWNER'S NO.

19	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL Mo.	TOTAL To Date
NOV.																																	
DEC.																																	
JAN.																												X			X	2	2
FEB.										X	X	X	X			X	X	X		X	X	X	X										

FOURTH ANNUAL INTERNATIONAL EGG LAYING CONTEST
STORRS AGR. EXP. STATION---CONN. AGR. COLLEGE, STORRS, CONN.
NOVEMBER 1, 1914 — OCTOBER 31, 1915

VARIETY White Wyandottes | RECORD 1ST YEAR | PEN NO. 14
OWNER Tom Barron, | BAND NO. 132
OWNER'S ADDRESS Catforth near Preston, Eng. | OWNER'S NO.

19	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL Mo.	TOTAL To Date
NOV.						X			X	X	X		X			X		X		X	X		X	X	X	X		X	X			15	15
DEC.	X	X	X		X	X	X		X	X	X		X	X	X	X		X	X	X	X	X	X	X		X	X		X	X		24	39
JAN.	X	X		X	X		X		X	X	X	X		X	X	X	X	X	X		X	X	X	X	X		X	X	X	X		24	63
FEB.		X	X	X	X		X	X	X	X		X	X	X		X	X	X	X	X		X	X										

SCORE CARDS THAT TELL THE REAL STORY

Incompleted egg-laying records (up to February 23) of the two White Wyandotte hens shown in Fig. 12. The one which scored higher by ordinary standards has laid very few eggs, while the one which scored lower by ordinary standards has proved to be an excellent layer. In the light of such records as these, breeders are beginning to ask themselves whether the present poultry standards encourage breeding merely for fancy points or for real usefulness. (Fig. 14.)

is for the genetist, largely by biometrical methods, to test out the utility points and for the standards to recognize these at their actual value when discovered. Efforts have already been directed to this end by investigators. If the protein content in the corn kernel is roughly proportioned to the amount of horny endosperm, as seems to be the case, this character can be added to the score card for judging high protein ears, to adduce a single example from plants.

HENS SHOULD LAY EGGS.

An example from poultry may be taken from Table II. This table shows the relative value of ear-lobes, beak and legs, and of these parts combined, in selecting Leghorns with high egg records. If these same relations are found to hold for other times of the year than October, when the color records were taken, and are found to be equally significant under other environmental conditions, it would not be difficult to assign to color in different parts of a bird in this breed the proper number of points on the score card. It does not seem unreasonable to disqualify from the show room any hen or pullet that does not show evidence of being in a laying condition, and to refuse to admit to registry in the "Standard of Perfection" any new breed that has not made a reasonable record in an egg-laying contest. Such a procedure would do much to improve the laying qualities of the different breeds.

With the pure fancier this paper has no complaint. He is to the agricultural breeder what the amateur photographer is to the professional. He has done much for genetics, but he breeds primarily as a pastime, not for profit. The sale of pets is of course a profitable

industry, and even the agriculturist must often cater to the demand for fancy points in his market. The public prefers a red-skinned apple to a yellow one. In some markets, asparagus must be bleached, in others green to obtain a ready sale. In New York City on the first of last February the market quotations listed white shelled eggs at 37 cents a dozen and brown eggs at two cents cheaper, while in Boston, brown eggs are preferred. Other instances could be given to show that the public needs educating to the real value of products as well as the showman to the real value of his producers.

An attempt has been made to show that fancy points have an undue prominence over utility points in the show room and thereby tend to pervert the aim of the breeder. An example is given from poultry of the demand for yellow beaks and legs in show birds of certain breeds, despite the fact that the presence of this yellow is indicative of poor laying ability. It is suggested that the show room standards be changed and greater account be taken of yield; that judges disqualify for characters indicating low yield; that efforts be made to discover to what extent visible characters are correlated with high production and that points be allowed commensurate with the degree of this correlation.

NEW PUBLICATIONS

PLANT BREEDING, by L. H. Bailey. New edition revised by Arthur W. Gilbert, Ph. D., professor of plant-breeding in the New York State College of Agriculture at Cornell University. Pp. xviii+474; 113 illus. The Rural Science Series (edited by L. H. Bailey); The Macmillan Company, New York, 1915. Price $2.00 net.

PROFESSOR Bailey's pioneer text book on plant breeding, issued 20 years ago, has gone through numerous editions, and has now appeared as an almost entirely new book, summing up the present state of knowledge on the subject and becoming what is probably the best and most complete practical handbook of plant breeding in the English language. Intended for college students, the book deals with the statistical side of heredity more than the average horticulturist will enjoy; but in this feature will perhaps lie its greatest value to the man or woman who intends to make plant breeding a profession. An interesting chapter is given to the origin of well-known varieties of cultivated plants, and another to a survey of organized work in plant genetics—"The Forward Movement in Plant Breeding." A compact glossary and extended bibliography are added, together with an appendix outlining laboratory exercises for students.

To Grow Pedigreed Seeds

Beliving that the present war furnishes an excellent opportunity for America to capture some of the seed-producing business hitherto held by Europe, farmers of Northern Idaho have formed the Kootenai Valley Seed Growers Association, of which C. W. H. Heideman, Bonner's Ferry, Idaho, is secretary. The organization is coöperative in nature and advertises that its seeds "were grown by scientific methods of selection and are as near pedigree seeds as it is possible for human to grow them." As a guide to scientific procedure, the secretary has been commissioned to compile a popular handbook on the application of modern plant-breeding methods to commercial seed growing.

HARDIER SPINELESS CACTUS

Present Commercial Varieties of Prickly Pear Suited to Very Limited Range—Selection of Favorable Variations in Native Species Gives Promise of Providing Forms That Will Stand Zero Temperature.

David Griffiths

Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

IN a consideration of spineless prickly pear culture on anything like a comprehensive scale, the first and most important necessity consists in making it applicable to a greater territory. At present, the crop is not to be considered in our southwest, except in California and the least frosty portions of Arizona. It is not to be thought of in New Mexico, nor Texas, except in the southernmost extremity; and the indications are that it can be only imperfectly grown on our gulf coast, and is adapted to only a portion of the coastal region of Florida. So far as the mainland of the United States is concerned, then, there is only a comparatively small territory to which the present spineless varieties are applicable.

The limiting factor is one of temperature, the plants not being able to endure temperatures any lower than the orange. Just where the danger point lies is as difficult to state as it is with any other crop; because contributing factors are numerous, poorly understood, and exceedingly influential in varying the effect of given temperatures.

During the January freeze of 1913, in California, the Department's collection was subjected to a temperature of 13° F. for at most but a few hours; only two or three spineless species escaped injury, the majority being very severely hurt and all young plants as a rule killed. In previous years, the same collection has been severely injured by temperatures of 20° of longer duration. During the freeze of 1913, on the other hand, one of the Department's coöperators at Lakeside, California, had an actual record of 8° F. in one of his cactus plantings, and the injury done was negligible. In one of the Department's plantings at San Antonio, Texas, a temperature of 20° F. with sub-freezing weather for 24 hours has always proved fatal to all of the conventional spineless species now so abundant in California, and so widely advertised in the South and Southwest generally.

From this brief survey, it will be readily seen that exact temperatures give us no more information with this crop than with any other. The data of value here as with other crops is gained from actual growing records. The region in which the plants succeed is the one to which the crop is adapted. The various varieties have now been tested over a wide enough territory so that we are able with certainty to limit the crop as at present constituted to the region suggested above.

BASIS FOR IMPROVEMENT.

At the present time, there is in this country a considerable wealth of material to work with. There are four or five good botanical species of rapid-growing spineless prickly pears. These in turn can be divided still further into what would in other groups be recognized as at least twice that number of horticultural varieties. Besides these 10 or more forms already spineless, there are not far from 100 species of all grades of spininess having qualities which place them in the economic class and make them of economic possibility. But since we have in mind mainly the production of spineless forms suitable for colder territory, species applicable to our use become very much restricted in numbers. For reasons which will become apparent later, our hopes center

in a few species outside of the known spineless forms.

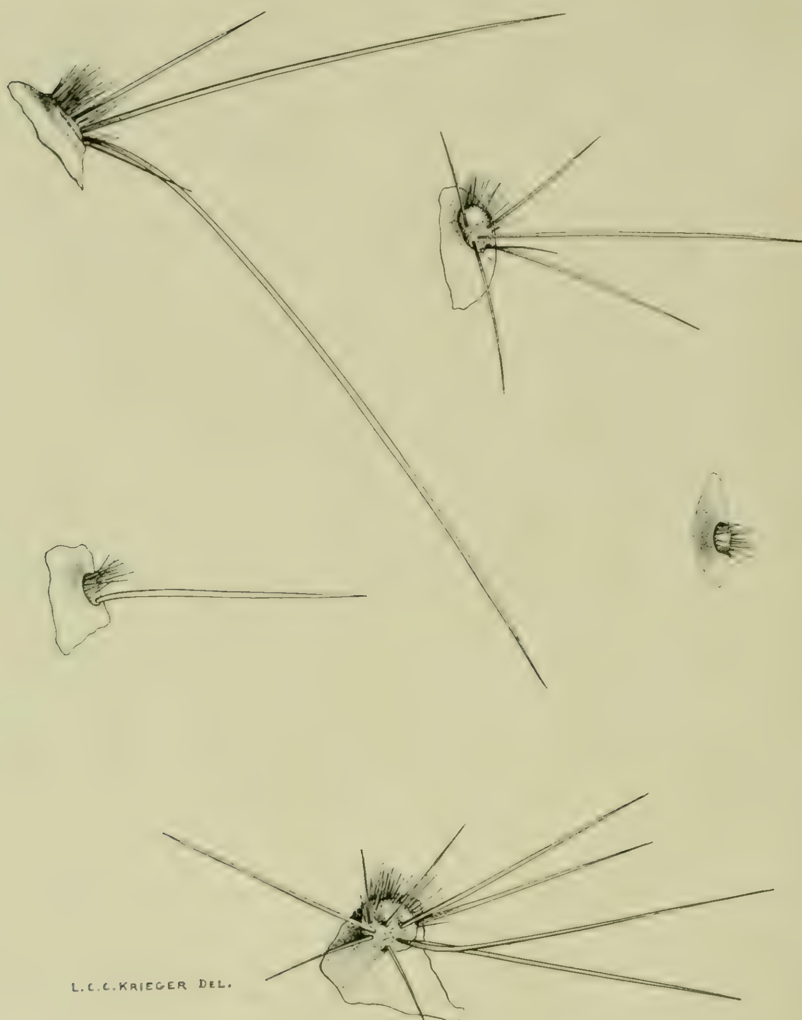
Since all of the conventional spineless prickly pears are tender to frost conditions in this country, there is no hope of making decided improvement in this group of plants within itself. Dependence must necessarily be placed in the native species of the United States, which are best adapted for this purpose. In the selection of our plants, we must keep constantly in mind three requisites; the first and foremost being tonnage of production; second, resistance to cold; and third, spinelessness. Since the crop is of low nutritive value, comparing with sorghum hay at a ratio of 10 to 1 (*i. e.*, 10 pounds of green succulent pear equal in feeding value 1 pound of good sorghum hay), it is absolutely essential that a comparatively large tonnage be secured in order to make it worth while to grow the crop. Our task is so to increase resistance to cold that the crop may become applicable to a greater territory. But while doing these two things, it is imperative that we maintain the spineless character. However, we may allow our notions of spinelessness to become rather lax, for cattle are able to thrive on quite rough feed; and absolute spinelessness has never been attained in any of the species thus far. All of the so-called spineless species bear a few of the annoying spicules; and the majority of them, some spines as well. Nevertheless, the so-called spineless species of today are sufficiently smooth for cattle to eat with impunity; and we can, therefore, adopt the average of them as our standard of spinelessness very safely.

The conventional spineless forms meet the requirements not only of spinelessness, but a number of them are sufficiently productive as well. Our problem, therefore, is very much simplified in that we need to increase hardiness only, while maintaining, of course, the other two characteristics. As stated above, there is practically no hope of being able to increase the hardiness of these forms within themselves; for they are all tender. It is, therefore, necessary to look for characters outside of the present spineless species which can be bred into them. The native hardy species of this country—and for obvious reasons it is to the species of this country that we are obliged to turn for hardy characteristics—are for the most part spiny, and on the whole unpromising. They furnish stock food after being singed, but that does not concern us in this study. Many of the species, however, are very variable in spination; and some spiny hardy natives of Texas have individuals almost if not quite destitute of spines; although they all have plenty of the spicules. The latter, however, are also variable; and individual plants may be found with comparatively few of them present. These are the main characteristics which appear to bear upon our problem of increasing the hardiness of these plants; and it has been with such ideas in mind that the work along this line has been conducted.

NATIVE SPECIES EXAMINED.

For the past seven years, a constant watchfulness has been exercised to discover the least spiny of the hardy native species; and the attempt has been not to go too far north for these, but to work with the expectation of pushing the crop, say 200 miles farther north, or in other words, to increase hardiness so that the species will stand, we will say, temperatures of 0° F., or possibly a little lower. It has been considered that an attempt to make too great leaps will inevitably lead to disaster, for the species which are hardy to temperatures of 20° below zero are very unpromising both from the nature of their spines, and from their small stature and slow growth. Our ambition has been rather to produce economic spineless species which will thrive in the present pear region of Texas, say as far north as Austin.

Thus far, expectations have in a measure been fulfilled; and three, possibly four or five, species have been selected which are very promising for further breeding purposes. It is rather remarkable that in these selections, field judgment has not always proven reliable; for plants have not always



A WIDE RANGE OF VARIATION

A single pulvinus or cushion of spines from each of five varieties of the prickly pear known to botanists as *Opuntia cacanapa*. The long stiff spines vary in number from 0 to 9. It is not difficult to breed most of the spines out of a variety of prickly pear, but it is much more difficult to eliminate the short, tender spicules which cluster around the base of the spine. Most varieties of "spineless cactus" lack spines but still possess a certain number of spicules; this makes them unpleasant to handle but does not absolutely prevent their use as stock feed, since cattle can handle quite rough feed. Illustrations about one-half natural size. (Fig. 15.)

turned out as well as was expected when they were found. Forms of *Opuntia dillei* were once looked upon as promising; but these have long since been proved of no value—at least so far as three or four forms which we have carefully studied are concerned. In all of these investigations, the desire has been to secure as a starting point for hybridizations the least spiny plants possible consistent with a reasonable expectation of rapid growth. Out of 3000 forms collected only three, with a possible additional two more, are now

PROMISING MATERIAL FOR BREEDING

A practically spineless selection of *Opuntia cacanapa* under cultivation at San Antonio, Texas. The plant is four years old from cuttings, and probably not more than three or four spines will be found on the entire plant. This does not mean that spicules are absent, but their presence is not a fatal defect. The species here shown is a native of Southern Texas and a product of selections by the U. S. Department of Agriculture. Numerous varieties are recognized—in fact, the great range of variation (see Fig. 15) in this species is one of the characteristics which makes it most suitable for the attention of the genetist. (Fig. 16.)

A COMPLETELY SPINELESS CULTIVATION

Two-year-old plant of *Opuntia subarmata*, a native of Southern Texas and a result of selection in the work of the U. S. Department of Agriculture to produce hardier varieties of spineless cactus for the Southwest. This plant is perfectly spineless, and the number of spicules is not large. This species will stand from 12° to 20° more cold than the commercial varieties of spineless cactus at present known, which are too tender to be grown except under most favorable conditions. (Fig. 17.)

considered at all promising for this purpose. These, we think, belong to as many botanical species.[1]

As stated in a previous publication, some of the species which are fed very successfully in southern Texas are not adapted at all for our purpose because of being persistently spiny. However, in one general region of Texas the native species normally are very variable in spination; and occasionally plants are met with which are very nearly or even quite destitute of spines. The greatest variation the writer has ever known in a single species of prickly pear is exhibited in *Opuntia cacanapa*. This species as conceived when it was first described has one erect white or bone-like spine to each areole or cushion of spines. Further study has proven that its spines may be three or even six in number; and one plant of "cacanapa" has been found, which is nearly destitute of spines, and has even the number of spicules somewhat reduced. Vegetatively propagated selections from this are now entirely destitute of spines. The latter form is described beyond; but it will be instructive at this point to glance briefly at some of the diversities which are encountered in this species—or no doubt some one will say "group of species;" for we have here either one species, or we have more than one. The important fact, though, from our standpoint, is that one form is nearly or quite spineless, and remains so when propagated vegetatively.

MUCH VARIATION FOUND.

When this species or this group of species is studied broadly, one finds greater differences than constitute good species elsewhere in the genus. There is, however, a scarcely definable something that links the different forms together unmistakably. And this something is a quality that does not require a trained botanist to recognize. Indeed, the Mexican peon will point to all these forms with unerring certainty as "caca-

[1] A peculiar condition is found in one California species wherein the variation occurs, not between the individual plants but upon the joints of a single plant. This has not yet yielded to selective influences.

napa." It makes no difference whether it is the form with the single erect spine, the smooth, or the exceedingly spiny one that he is dealing with. Sometimes he will apply a qualifying adjective to designate the different forms. But they are all "cacanapa" to him.

The artist has brought out the difference in fig. 15, so that little further need be said. It may be added, however, that the differences in what we consider varieties in this species are greater than those used to distinguish species in other groups. The differences are not confined to spines alone; in varying degrees, they are those of the entire range of characters used for taxonomic purposes. The species is typically glaucous; but many individuals are yellowish-green, and it is in the yellowish-green varieties that the greatest spination occurs. Typically, the joints are subcircular; but there is little regularity in shape, except in so far as the individual or groups of individual plants are concerned. There is, however, a striking similarity in the fruit of the entire group of varieties, a similarity possessed by this and one or two other species.

In the illustrations are shown differences in spination mainly, that being the most striking variation. With these spiny forms is to be compared the spineless, but not spiculeless, variety shown in fig. 15. There are but few species in southern Texas more spiny than *Op. cacanapa;* and likewise, no native species with fewer spines. There are other species which from some standpoints are more promising for breeding purposes in this pear region; but their constant spininess renders them unfit. This is simply another instance of the oft-repeated principle that those plants and those only are favorable objects for selection which have great range of variation.

Our experience with these plants leads us to think that there are no species more promising for increasing the hardiness of the spineless prickly pears than *Opuntia cacanapa, Op. ellisiana,* and *Op. subarmata.* To these may be added *Opuntia bentonii;* two or three other varieties rather closely related to *Op. subarmata;* and one apparently entirely without spines, but having spicules in about the same proportion as typical *Op. bentonii.* At present this is thought to be a variant of *Op. bentonii.* Since breeding work with these species is already well under way, it is desirable to have the forms we are using characterized and fixed in type as accurately as may be for purposes of later comparison as well as to record the facts of the selection of such rare plants among an abundance of very spiny species on the one hand, and on the other, very spiny individuals of the same species. It is very probable that the conventional tender spineless forms owe their origin to much the same process of selection as here employed; but it has continued through many generations of time. Some of it has been conscious and some unconscious; some of it American and some European.

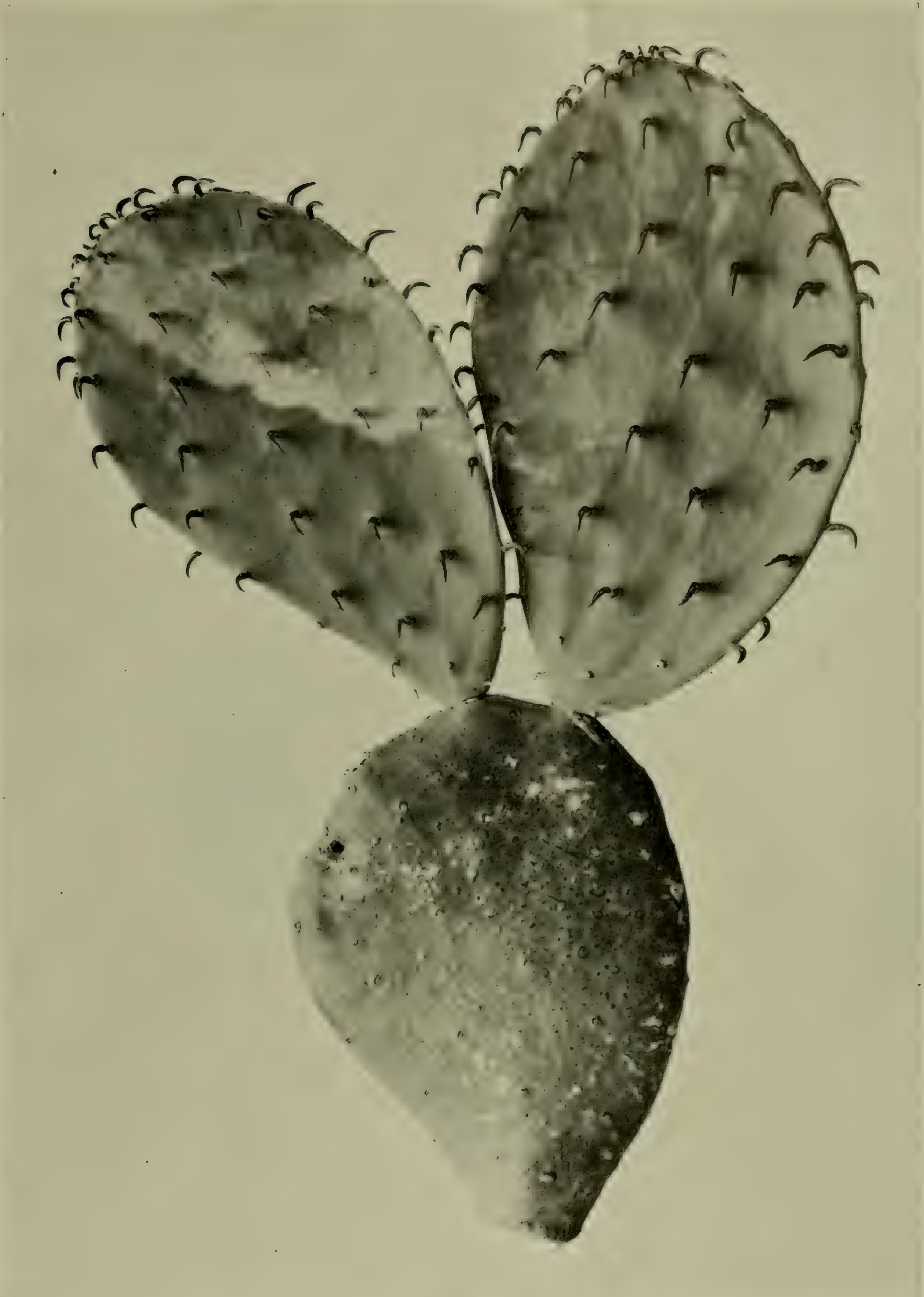
Opuntia cacanapa Griffiths.

An erect or ascending, spreading, open-branched species, reaching a height of 1½-2 m., and a spread of branch of 1½-2¼ m.; joints subcircular, about 16 x 18 cm., glaucous, gray-green, when mature, but turning more yellowish by loss of bloom in age; areoles white when young, turning tawny at maturity, and dirty gray in age, subcircular to broadly obovate, 3 mm. long on edge, smaller on sides of joints, becoming subcircular and somewhat larger when old; leaves long, prominent, oval in section, arising from an abrupt small tubercle, 1 mm. high, 16-17 mm. long, subulate, cuspidate, broadly arched backwards; spicules light yellow, unequal, scattered through entire edge of areole, but more prominent above, with the wool in the center and 1 or 2 mm. high on edges of joints, 3-5 mm. long, but much shorter on sides; spines almost absent; only an occasional one in a rare areole 1 or 2 cm. long, seldom seen; flowers deep yellow, about 7 cm. in diameter when open, and petals 5 cm. long, filaments yellow above, greenish tinged at base, style white, stigma white, 8-parted with long linear divisions; fruit red throughout, small, obovate to subglobose, 3-4½ cm. in diameter with comparatively thick rind.

This variety of *Opuntia cacanapa* is of medium rapid growth, somewhat slower than *Opuntia lindheimeri* of the San Antonio region. In structure it is somewhat more fibrous, and the joints are not so thick. This is characteristic of all of the varieties of this species.

DETAILS OF A VALUABLE PRICKLY PEAR

Old and young joints, flowers and bud of *Opuntia subarmata*, an entire plant of which was shown in Fig. 17. This plant is a perfectly spineless one, with few spicules, and was selected from a mass of spiny plants of the same kind in the Devil's River region of Texas. It is now being propagated by cuttings, so that it is not likely to revert to the ancestral, spiny condition of the species. The old joint, at the bottom, shows the spineless condition; the young joint, above, shows the rudimentary leaves, which drop off in a few weeks. It will be remembered that the prickly pear plant consists merely of stems, which are flattened out; the leaves were long ago reduced, in the process of evolution, to slight fleshy protuberances such as here shown, which are soon lost. (Fig. 18.)



A DESIRABLE FORM, READY TO HAND

The Mexican population of Southern Texas is believed to have produced this admirable spineless prickly pear, *Opuntia ellisiana*, by conscious or unconscious selection of the hardy but usually spiny native species. Here the spines have not only been abolished, but the spicules have been almost wholly eliminated, as well. In nearly all other spineless forms, the spicules are more numerous. The fleshy hooks on the young joints at the top are rudimentary leaves, which will soon drop off. Professor J. C. Ellis of the University of Texas first discovered this form among the Mexicans in the outskirts of Corpus Christi, Texas. It is hoped that the hardiness of the form here shown, which will endure a temperature of close to zero, Fahrenheit, can be combined with the valuable commercial qualities of other parents, and an ideal spineless cactus produced for the Southwestern States. (Fig. 19.)

The plants are upright in habit, and while not compact in growth, they are stout and firm and never lax, sprangly or ungainly in habit. Its slightly fibrous condition is the main disadvantage for breeding purposes. However, this may be mitigated if characters happen to be properly combined, in that it is desirable to add strength to some of our present spineless forms of the Indian fig group. Being free from spines, not especially infested with spicules, and able to withstand temperatures of the San Antonio to Austin, Texas, regions without any injury, it is one of the promising forms for increasing hardiness of the more tender spineless stocks. Figure 15 accompanying the text well illustrates the great range of variation in spination of this species.

Opuntia subarmata Griffiths.

Plant upright to ascending, rather compactly branched, making a shrub 1¼-1½ m. high, and nearly 2 m. in diameter; joints oval, obovate to subcircular, commonly 17-25 cm. in diameter, broadly to narrowly rounded above, glaucous, bluish-green, changing through yellowish to brownish, and finally to gray, scaly; areoles elliptical to ovate or subcircular, 3-6 mm. in longest diameter, 3½-4½ cm. apart, tawny, changing to dirty gray or black, enlarging but slightly with age; spicules yellow, about 2 mm. in length, never formidable, numerous, nor increasing in length with age; spines none; flowers yellow, developing a faint tinge of red along midribs of petals as day advances, opening at 8:00 a. m., and fully open by 9:00, 7-8 cm. in diameter when fully opened, petals 4 cm. long, filaments white above, greenish below, style white below, very slightly greenish tinged above, stigma large, deep, dark green, 11-parted; fruit purple throughout, bearing light tawny subcircular areoles 1-2 mm. in diameter, having a small central tuft of yellow spicules; seeds flattened, regular, about 4 mm. in diameter, prominently notched at hilum, with marginal callus about ¾ mm. wide.

This species is based upon this spineless form, two collections of which have been made in the type locality, neither one of which has developed any spines under cultivation. Other closely related forms, considered to be of the same species, have been secured in the same locality. They have yellowish bonelike spines an inch or more long, in very varying numbers. The cold resistance of the species is probably somewhat greater than that of cacanapa; and on the whole, it is a more promising species for breeding purposes, for it more closely resembles the best native economic species of Texas in both fiber content and succulence. It was selected some years ago in the region of Devil's River, Texas, where the spiny forms are common enough; but this spineless one is rare. It is found at the base of the limestone cliffs, so abundant in this region. Although rare, I have seen three or four plants which were perfectly spineless. It has been vegetatively propagated at San Antonio and Brownsville, Texas, and Chico, California. At none of these places have any species been developed.

Opuntia ellisiana Griffiths.

Plant spreading, ascending, laxly to compactly branched, 1-1½ m. high, and 1¼-2 m. in spread of branch, depending upon moisture and fertility conditions; joints light, pale, glaucous, green, when young, but yellowish shortly after maturity, broadly obovate, about 20 x 24 cm., slightly elevated at areoles when young; areoles at first almost cottony white, turning gray, and finally black, small, 2-3 mm. in diameter, after leaves have fallen and maturity has approached, made up of a central papillum in which the spicules are produced surrounded by a depressed groove separating it from the outer zone of gray or white wool; leaves long, prominent, circular in sections or slightly flattened, subulate, cuspidate, broadly arched backward, 12-15 mm. in length; spicules light yellow, never prominent, scarcely visible, few and only 1 mm. or less in length, scarcely distinguishable except by feeling from the central papillum of wool in which they are situated; spines entirely absent; flowers deep yellow, changing to orange, reddish when closed, some of the outer perianth segments dull, greenish red in bud, about 6 cm. in diameter when open, filaments and style white, stigma very light greenish yellow, 7-parted; fruit pyriform to hemispherical, deep reddish purple throughout, young ovary thickly beset above with small white subcircular areoles 3 mm. apart, and 1½ mm. in diameter, the wool being prominently raised to 1 mm. or more in a compact columnar tuft, from center of which are produced 1-2 delicate yellowish fugaceous spines, 2-3 mm. long and 1-3 or 4 minute spicules 1 mm. long or less, the lower part of ovary having only 1-3 spicules, and the areoles being much farther apart.

It is thought that all of the material of this species in cultivation today has been grown from stocks secured at Corpus Christi, Texas. The origin is not known, but it has evidently been in cultivation a long time. It is now

quite widely distributed in collections due to the efforts of the Department and Professor J. C. Ellis, who first found it cultivated by Mexicans in the outskirts of Corpus Christi. There are indications that it has been derived by selection from native forms of southern Texas; but the evidence is not conclusive. It is perfectly hardy at Austin, and doubtless is fully as hardy as *Op. cacanapa*, and possibly as hardy as *Op. subarmata*. In growth it is not as good as the other two; but it is much more smooth, approaching if not quite equaling in this respect the smoother forms of the Indian-fig group. Another feature is the few spicules on the fruits. On these accounts, the species is quite promising for breeding purposes.

While these three forms appear to be the most promising, and are the ones upon which the greatest effort is being expended at present, it is not at all impossible that other selections may be made of as great, if not even greater merit. One nearly spineless form recorded under my collection No. 9087, from Webb County, Texas, is a rapid, very succulent, wavy jointed, compact form, as good as any of the above, were it not for its few spines. It is probably very close to, if not the same as, forms of *Opuntia subarmata*, mentioned on another page. Another selection made last year is a remarkably smooth form of *Op. bentonii*. It is thus far devoid of spines, but has quite prominent spicules. This grows rapidly, but its joints are as thin as those of *Op. cacanapa*.

The difference in cold resistance of these forms is not great. They will withstand from 12 to 20° lower temperatures than the conventional spineless ones of today; and will probably all be hardy throughout the entire pear region of Texas.

SUMMARY.

The main problem associated with spineless prickly pear culture today is to increase the resistance of these plants to low temperatures.

Hardy native species of the United States, more particularly of central Texas, are thought to be the most promising source of hardiness.

Three, with a possible additional two, selections have been made from the Texas region which are considered very promising, and which have been successfully crossed with the tender spineless species.

The selections already made have resulted in the production of forms of native hardy species which are entirely devoid of spines, and which remain spineless under cultivation. These forms are also as rapid of growth as the spiny natives of the Texas region.

Bud Selection Fails

Bud selection from high producing and low producing strawberries carried on through twelve years showed absolutely no gain in productiveness by selecting runners from high producing parents, at the Missouri agricultural experiment station.

Raspberry Breeding

In the work of raspberry breeding at the New York State agricultural experiment station (Geneva), it is reported that "two series of crosses involving over 700 seedlings have proved '*Rubus neglectus*' to be a hybrid between *R. strigosus* and *R. occidentalis*. At the same time some very interesting white fruited seedlings have appeared and also a seeming mutation, a dwarf, which appears to indicate from its numbers that certain of our raspberries carry dwarfness as a recessive character. Although the crossing of the named varieties has proved unusually successful, much of the future work with both Rubus and Ribes will be in hybridizing species. Already some interesting hybrids have been secured between *Ribes nigrum* and *Ribes oxyacanthoides*. To further this hybridization work the station is making a collection of species of these two genera."

THE POMERANGE

A Natural Hybrid Between the Orange and Pomelo

THE readiness with which members of the Citrus family yield results to artificial cross-pollination, as witness the citrange and tangelo, gives rise to some wonder as to why there are so few natural hybrids in the family. The bees and other insects, whose constant visitation of the flowers must cause, in the course of time, a frequent interchange of pollen between the orange, lemon, pomelo, lime and citron, seldom make their influence felt in the production of new fruits. The most probable solution of the matter, it seems to me, is that the fruit is nearly all sent to market, and the seed that might bring forth the hybrids is thus lost to cultivation.

Two well-marked hybrids of the pomelo have appeared in the seedling orange grove of the late E. D. M. Perkins, at Winter Garden, Orange County, Florida, and both were produced without the intervention of artificial means.

Soon after the disastrous freeze of February, 1895, Mr. Perkins left his grove and removed to the National capital. For fifteen years the place was practically neglected. Groups of sprouts growing around the stumps of the frozen trunks became large bearing trees.

During a sojourn on his place in the winter of 1910, Mr. Perkins noticed a tall tree having the general appearance of the pomelo, but which bore fruits of a deep golden color, egg-shaped and of large size, some of them weighing as much as two pounds each. They were found to be quite tart, with a thick, white inner rind having the characteristic bitterness of the pomelo, and with abundant seeds. The flavor was quite like that of the pomelo, but with more acid than the better sorts, although the fruit was found to improve in sweetness as it hung longer on the tree. The fruits were found growing in large clusters like the pomelo, but the color was like that of a superior orange. There was no russeting of the coat, and the surface was smooth and glossy.

One peculiarity of the Kegler orange, with which Mr. Perkins stocked his grove, was a plainly marked ring or nimbus, from one to one and one-half inches in diameter, at the blossom end of the fruit, indicating some admixture of navel strains, and this sort of a circle was found on the same place on the new fruit.

Specimens of the new hybrid were sent to the writer by his father, on whose place it was found, with the statement that it was undoubtedly a natural cross between the pomelo and orange. The name of "pomerange" was suggested for the fruit by the writer when he forwarded the specimens to the pomologist of the Bureau of Plant Industry in January, 1911, and it was described and entered under that name at the time, in the Bureau. So far as known, the tree has borne regular crops since, maintaining in every particular the size, color and quality of the fruits first noticed.

The flavor of the pomerange is rather too tart, when it first ripens, but later a more distinct orange taste develops. The fruit is a real pachyderm, as the skin is in some places, notably at the stem end, nearly an inch thick, but this feature adds much to its good shipping qualities. The tree is now owned by Adam C. Perkins, of the Post-Office Department in Washington, a son of the original owner and discoverer of the fruit.

The other hybrid, probably a cross between the pomelo and the lemon, is of a very tart and somewhat bitter taste, and perhaps worthy of only a passing notice. In shape it is like the ordinary pomelo, but of a deeper color, and the oil cells are very large and abundant.

LINDSAY S. PERKINS.
Washington, D. C.

The

Journal of Heredity

(Formerly the American Breeders' Magazine)

Vol. VI, No. 5 May, 1915

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The Journal of Heredity is published monthly by the American Genetic Association (formerly called the American Breeders' Association) for the benefit of its members. Canadian members who desire to receive it should send 25 cents a year, in addition to their regular membership dues of $2, because of additional postage on the magazine; foreign members pay 50 cents extra for the same reason. Subscription price to non-members, $2.00 a year, foreign postage extra; price of single copies, 25 cents.

Entered as second-class matter February 24, 1915, at the postoffice at Washington, D. C., under the act of August 24, 1912.

Date of issue of this number, April 26, 1915.

PROBABLE ANCESTRAL TYPE OF ZEBU CATTLE

Timor bull at Pandacan Quarantine Station, Philippine Islands. He is probably nearly full-blood Banting. The Banting (*Bos sundaicus*) is a wild bovine of the East Indies which, according to C. Kellar, is the ancestral type of the modern zebu cattle; although most students think that hybridization has introduced other elements into the zebu make-up. Noteworthy features of this bull are the peculiar neck, dewlap running back to the navel, and hump somewhat similar to that of the carabao or water-buffalo. Photograph from the Bureau of Agriculture, Manila. (Frontispiece.)

ZEBU CATTLE IN BRAZIL

Imported Stock Crossed on Native—Hybrids are Popular with Ranchers—Hardy, Disease-Resistant and Fairly good Milkers—High Prices Paid—Possibilities of Interest to United States.

B. H. HUNNICUTT

Director, Escola Agricola, Lavras, Minas Geraes, Brazil

ZEBU cattle are attracting attention from animal breeders in all the warmer parts of the world at the present time, and are assuming particular importance among ranchers in the southern United States, because of their relative immunity to the disastrous Texas fever.[1] Many genetists believe that by crossing the zebu on native stock, a new breed can be produced that will be of great value; and as Brazil has been making such an experiment on a very large scale for many years, I think it will be of interest to breeders to know what the results have been as they appear to me and to other students.

The zebu (*Bos indicus*), as is well known, is a native of the Indo-Malayan region, and was certainly domesticated several thousand years before the beginning of the Christian era. According to C. Kellar, it represents nothing more than a domesticated Banting (*Bos sundaicus*), although most students look on it as the result of hybridization. The name "zebu" is said to have been given it by the French naturalist Buffon, who described it in his Histoire Naturelle (published from 1749 to 1767) from specimens which he had seen in a menagerie, and which had been given by the showman the apparently fictitious name of *zebu*, a name not known in India.

As far as I have been able to learn, the first importations of zebus to Brazil were made about forty years ago[2], one of the earliest being by Sr. Acacio Americo Corréa de Azevedo, who secured a bull and cow from London Zoological Gardens. It is probable that all the early importations[3] were made from London by the English firm, Crashley & Co.; only in later years have the importations on a large scale been made direct from India.

CATTLE BRING HIGH PRICES

The breed gained rapidly in popularity. Some twenty years ago an offer was made[4] in Uberaba, Minas, of 42 contos de reis for a zebu bull. This is about $14,000 in American gold; and, by the way, the offer was refused. The owner of this bull amassed quite a fortune and the herd is still considered the best in Brazil. It is now in the hands of the son who has become a millionaire as a result of his reputation

[1] For an account of what has been done in this direction, see Borden, A. P., "Indian Cattle in the United States," *American Breeders' Magazine*, I, 91, Washington, 1910 (also in annl. report A. B. A., VI, 1910); "Zebu Cattle Resistant to Texas Fever," *ibid.* III, 233, 1912 (see also twenty-sixth annl. report of the Bureau of Animal Industry, Washington); Nabours, Robert K., "Possibilities for a New Breed of Cattle in the South," *ibid.*, IV, 38, 1913. For a discussion of the genetic problems involved in zebu crosses see Nabours, R. K., "Evidence of Alternative Inheritance, etc.," in *Amer. Naturalist*, July, 1912, and Cook, O. F., "Mendelism and Interspecific Hybrids," *ibid.*, April, 1913.

[2] Inquerito sobre o Zebú, Sociedade Nacional de Agricultura, Rio de Janiero, 1907.

[3] It is probable that, as Nabours refers in his article on Zebu cattle (Possibilities of a New Breed of Cattle, R. K. Nabours, *American Breeder's Magazine*, Vol. IV, No. 1) to the introduction into the United States of Indian cattle characteristics, especially in the Southwest, through Mexico from Spain, the influence of the breed was introduced into Brazil soon after the discovery. Or as Anderson says ("A Fazenda" Anno 111, N. 29, Out. de 1912) in his letter to Dr. Travassos, there may have been importations into northern Brazil several centuries ago.

[4] "A Criação do Gado no Brazil," M. Bernardez, Imprensa Nacional, Rio de Janeiro, 1909.

SUPERB TYPE OF THE GUJARAT BREED

"Ceylão," herd bull on the estate of Sr. José Caetano Borges at Uberaba, Minas Geraes, Brazil, was imported from India, and is considered to be almost a perfect specimen of this variety, while the herd which he heads is reputedly the finest in Brazil, where zebu cattle have become immensely popular in some districts during the last generation. (Fig. 1.)

for these cattle. Most of the photographs for this paper are from the herd of this breeder.

It has not been possible for me to determine exactly the number of Indian cattle that have been imported into Brazil. The greatest activity in importations direct from India seems to have been during the period 1907-1910 when one firm alone in Rio de Janeiro imported over 1,200 head. In 1910 the number imported[5] was 620, in 1911 only ninety-three, and since then even less.

What is known as the "Triangula Mineira," a triangular section of the state of Minas Geraes to the extreme western part of the State, extending from the city of Uberaba to Araxa, is the stronghold of the zebu in Brazil,[6] the place where the greatest number of pure bred zebus are to be found, and where stockmen are enthusiasts for the breed and long prices are paid for exceptional animals.

It is probable that throughout the whole of the vast state of Minas Geraes hybrids of the zebu will be found, so largely have they been scattered during the last few years. No doubt Minas is the State where they are most bred, but they are also raised in the adjoining States, Rio de Janeiro, Espirito Santo, Goyaz, Bahia and to some extent in the

[5] Foreign Commerce of Brazil, Ministro da Fazenda, Rio de Janeiro, 1912.

[6] For a good description of this region see Industria Pecuaria, pages 39-59, Imprensa Official, Bello Horizonte, 1912.

"THE BEST ZEBU COW IN BRAZIL"

"Polonha," a pure-blood Gujarat, is the property of Sr. José Caetano Borges of Uberaba, Minas, and is considered by him to be the best cow of this breed yet imported from India. Her owner has become a millionaire, as a result of the reputation of his herd. (Fig. 2.)

states of the northern part of Brazil. Up until 1907 they were unknown in some of the northern States but it is probable that they have spread since then to all the northern States. They have never been in much favor in São Paulo or in any of the southern States, so far as I have been able to learn. The bovine population of Brazil is given at 30,000,000 and a large percentage now has at least a trace of zebu blood.

Many breeds or varieties of zebu are distinguished, both here and in India, but it will not be necessary to discuss them for the purpose of this article. The only ones of great commercial importance in Minas are the Gujarat and Nellore, although the Gir and Hissar are fairly common. The Gir is considered the best for milking purposes, but milk is not a primary consideration in the Brazilian cattle industry. No particular care seems to be taken to keep the various breeds separate, on Brazilian ranches, and they are freely interbred.

In January, 1914, I made a short trip with Messrs. P. H. Dorsett and Wilson Popenoe, agricultural explorers of the U. S. Department of Agriculture, to study the cattle industry of this part of Brazil on the farms of two important breeders, Snrs. Pedro and Cassiano Lemos of Pratinha, State of Minas Geraes. Their ranch, in an open, rolling, well watered and well grassed country, originally contained more than 160,000 acres of land, and most of it

A NELLORE-GUJARAT CROSS

The two principal breeds of zebu cattle in Brazil are the large, long-eared, long-horned Gujarat, and the smaller, more graceful, shorter-horned Nellore. This two-year-old bull, "Marmore," bred by Sr. José Caetano Borges of Uberaba, Minas, Brazil, is a cross between the two breeds mentioned. Brazilian breeders on the whole do not take any particular care to keep the various breeds of zebu separate, but mix them and cross them indiscriminately. (Fig. 3.)

is still in the hands of the family. Sr. Cassiano Lemos has about 900 head of purebreds and crosses, the latter being mostly half or seven-eights zebu, on the native or "crioulo" stock. These crosses in most cases have all the colors and characteristics of the Indian cattle.

ZEBUS ARE FECUND

The Lemos brothers speak highly of the zebu as a general purpose animal. The bulls are very fecund, and the cows, hybrid or purebred, are much more prolific than the native Brazilian cattle. The animals remain nearer together in the herd than do most cattle—an advantage when it is desired to corral them from the range. I saw one little boy sent out to bring in a large herd single handed.

The cows are milked only once a day—early in the morning. A good milker yields from 1 to 3 gallons: we saw a herd of 200 cows, pasture-fed only, which yielded 600 litres (634 quarts). After milking, the cows are turned out and their calves allowed to run with them and suck until about 2 o'clock in the afternoon, when they are separated until next morning; the calf is weaned at the age of 6 months. Mr. Lemos told us that they lose about 10% of their young calves from various causes—diarrhea or lack of care. The calf is a valuable assistant to the rancher at milking time, being turned into the corral with his mother and allowed to

MILKING IN BRAZIL

On the big ranches of Brazil the cows are only milked once daily—in the morning. They yield milk in most cases only while they have a calf at their sides. At milking time the calf is first turned into the corral with its mother and allowed to nurse; after it has sufficient nourishment, it is tied to the cow's right foreleg, the cow's hind legs are tied together, and the milker then "pails" her. In the photograph the calf is seen tied to his mother, with his head hidden by her dewlap. The milking qualities of zebus are somewhat disputed, but under favorable conditions it appears that they yield one or two gallons a day, and that the milk is of excellent quality. (Fig. 4.)

nurse. When the milker thinks it is time to check activities in that connection he ties the calf to the right foreleg of his mother, puts a rope around each of the hind legs of the cow, just above the hock, and ties them lightly together; then places the bucket between his knees and finishes the milk flow which the calf started.

We found that ticks will catch to some extent on a zebu, but do not seem to bother them at all. I have never known of a case where a native-born or imported zebu had tick fever. They are troubled to some extent with blackleg, against which vaccination is practiced; and also by the ox warble (*Hypoderma lineata*?)

It has been alleged that the zebu hybrids are very wild, even savage, as far as the third or fourth generation, no matter how docile the stock on which they are crossed. There is some truth in this, at least. They cannot be called tame cattle; but on the farms of the two gentlemen mentioned above I had occasion to note that where these cattle are carefully treated they give little or no trouble. I saw no cows milked that it was necessary to tie up in a trunk, as is claimed by some to be necessary. The purebred calves are caught every day and brushed so as to accustom them to handling.

Let me now give some opinions *pro* and *con* about the zebu from men who know him.

PRAISE OF THE ZEBU

Sr. Theopompo de Almeida[7] says, "I have imported breeding stock of various European breeds, among them Durham, Simmenthal, Brown Swiss, Polled Angus and Hereford; and in spite of the greatest efforts in well-cared-for artificial pastures to give the merited attention, the result has always been negative; however the zebu progresses admirably,

[7] Minas Geraes, July 15, 1914, p. 2.

fullfilling all my necessities. I have cows as good milkers as "Turinas" and Holsteins, with the advantage that their milk is of a much better taste.[8] As to the meat, it is the best possible." He speaks of how well the cattle stand being driven long distances to market,—he even uses them as pack animals.

Dr. Carlos Prates says,[9] "The zebu is, as proved, a breed resistant, easily acclimatized, and one that lives perfectly on our prairies, suffering little from the tick or other parasites. Further, it is proved that the first cross of the zebu bull with native cows give better products as to size, resistance and beauty; from this principally comes the preference of the zebu."

Dr. Alvaro da Silveira[10] remarks, " 'The zebu should be exterminated for the good of the nation's livestock industry' affirm those who say they are sustained by the solid basis of science. 'We shall continue to make use of the zebu because he makes us rich' say the breeders, sustained by the de facto profits that they receive from the undesired breed.

"It seems that, however patriotic the scientist may be, his love for the fortune of the zebu breeder is, in any case, less intense than that of the breeder himself for his property. And since the farmer is satisfied with this process of breeding, I am inclined to think it is *science* that is in error, because no one will believe that hundreds of Minas breeders will breed the zebu just to defend a bad breed, contrary to their actual interests."

Dr. N. S. Mayo as above cited says, "Among the good qualities of the Indian cattle are their hardiness, exemption from parasites, such as flies and ticks. Because of their size, strength and activity, Indian cattle are the best for the tropics."

Dr. L. P. Barreto[11] writes, "On all sides (in the state of São Paulo) the zebu is repelled with indignation. And this repulsion, happily, is the official doctrine; in our cattle shows (state of São Paulo) the zebu is excluded."

Sr. Manoel Bernardez compares the meat to that of the rhinoceros and says that to replace the native Brazilian cattle with the zebu would be to return to the stone age.

Dr. Eduardo Cotrim[12] goes into detail to prove that the zebu is undesirable from all standpoints, as a work animal (most traction work in the tropics is done with oxen) as a milk animal and as a beef animal. He even quotes the opinion of another, to which he evidently acquiesces, that it will some day be necessary to exclude the Indian cattle from Brazil by legislation.

These opinions have been given because there are two schools as it were, or rather two factions among the breeders in Brazil, one fanatically for the zebu, which is made up of the practical breeders who profit handsomely by breeding them, and those who go just as far to the other extreme, composed mostly of theorists and partisans of the European cattle (without much knowledge of the conditions under which the zebu cattle are proving so profitable).

The ideas thus suggested may have some weight with those interested in the United States or who intend crossing the Brahmin or zebu cattle for range purposes.

THE AUTHOR'S OPINION

To close I shall give two interesting opinions with which I agree.

Dr. Elias Antonio de Moraes[13] reminds us that "Indian cattle are to the bovines of other species what the mule is to the horse and the goat to the sheep," as to both vigor and health. He is also of the opinion that Brazil should be divided into three zones—the first near the large centers of consumption, for such breeds as Holsteins, Brown Swiss, etc. In the second zone cattle especially apt for the production of butter

[8] The author's observation is that zebu milk has a very rich and superior flavor.
[9] Industria Pecuaria, *loc. cit.*, p. 18.
[10] Industria Pecuaria, *loc, cit.*, p. 55.
[11] Industria Pecuaria, *loc. cit.*, p. 6.
[12] Inquerito Sobre o Zebú, *loc. cit.*, pp. 71-92.
[13] Inquerito Sobre o Zebú, *loc. cit.*, pp. 95-97.

and cheese, easily transported to market, should be bred. In the third zone in the interior the zebu would be the proper breed. This third zone corresponds to the ranges of the western United States; there and there only would I expect to see the zebu profitable.

There is this to be said, however, when the above evidence is being weighed, that hybridization with the zebu has hitherto been carried on in a wholly hit-or-miss manner, in most cases. Certainly this is the case in Brazil, and I understand that the breeding in Texas has not been accompanied by careful records. If the resources of the modern science of genetics were applied to the problem, it is possible that much better results would be secured. The importance of the problem for the tick-infested area of the southern United States, and for all warm parts of the world, is such that I strongly urge the United States Department of Agriculture to send competent zootechnists to Brazil to investigate the matter thoroughly. Brazilian breeders declare that the zebu is improving under the better care and feeding it gets in Brazil. Science ought to know exactly what has been accomplished here, and I am sure that the Brazilian government would be glad to cooperate with that of the United States, in an endeavor to place the facts on record.

ZEBU CROSSES IN TUNISIA[1]

M. Roederer, *Mateur, Tunisia*

ATTEMPTS to use zebu blood in improving tropical races of cattle are not novelties. The zebus and their crosses are, it is abundantly proved, resistant to the Texas fever and to anthrax; furthermore, they are very little disturbed by foot and mouth disease. This does not mean that the blood of these animals is exempt from the protozoa of Texas fever. Recent experiences have shown the contrary; but they are in smaller number and do not seem to act injuriously on the organism. Was it not a temptation, then, for us Tunisians, to try to cross our native cattle with stock from warmer and less favorable climates than the one under which we live?

One might say of the zebu that it is the "American stock"[2] of cattle breeding. Aside from the great advantages which it presents in resisting disease, the use of the zebu in crosses gives other precious results. The hybrids resist the heat perfectly—in fact, they thrive best in summer. After the hottest days, they return from the severe labor of plowing, with the eye fresh and the flank scarcely heaving. They fear cold weather more than anything else. Their great facility for assimilating dry fodder is an immense advantage in this country; they are less particular about the quality of their food than even the Arab cattle. Zebu breeding is, then, easy and presents few problems.

Now let us see what their crosses are like, as regards structure, weight, meat-production, milk-yield, fecundity and working qualities.

CROSSES OF GOOD SIZE

Cattle produced by breeding native cows to zebu bulls are much larger than the local Arab cattle. The head is delicate and expressive, the eye prominent, but the general appearance is spoiled by the large and ungraceful horns. The neck is short; the zebu

[1] Translated from the *Journal d'Agriculture Pratique*, Paris.

[2] An allusion to American grape vines, by the use of which as grafting stocks, French growers were able to recreate their vineyards after they had been nearly wiped out by phylloxera.—The Editor.

hump has disappeared. The fore-quarters are powerful, the chest deep, the shoulder very oblique, the legs delicate and nervous, the posture good. The line of the back is pretty, the short flank is vaulted, but the rump is sunken. The tail is very fine, long and well attached, the switch is voluminous. All the tissues and bones are fine, the muscles well developed, the belly as small as it could well be. The color is generally light and nearly always uniform.

The half-bloods (zebu x Arab) are much heavier than their brothers of pure Arab blood, sometimes reaching a weight, on the hoof, of 1,250 pounds. With a little addition of European blood through the mother, they can add another hundredweight to this. Butchers are eager for them, the meat being of excellent quality—no matter what has been said to the contrary—and the cut, much greater than that of most breeds, may exceed 60% of the live weight. They usually command a premium at the stock yards.

As work oxen, they are faster, stronger, more enduring than our native stock, but also less docile. A horseman would say that they show more blood. Nevertheless, they do not display a vicious temper to men who handle them.[3] One can break them to perfection by taking a little pains, by castrating them young, by always keeping them up in a stable and yoking them at the age of 2 or 2½ years. They then become first-class draft animals which, at the age of retirement from labor, become excellent beef animals.

They are easily kept in good condition and are always in shape to sell, in spite of inferior nourishment.

The cow has little milk, but no less, I should say, than most of our Arab cows. On the other hand, her milk seems to be very much more nutritious.

ASIATIC RACES BEST

The races of zebu are very numerous, and may be divided into African and Asiatic. Among the African races which have been tested in Algeria and Tunisia are those of Sudan and Madagascar. They yielded much poorer results than the Asiatic breeds. Among the latter, the little Brahmins of Ceylon are the most noteworthy; after them, the Nellores and the Malaysians are the most highly valued.

Zebu crosses, rather recent in Tunisia, have been made in Algeria for many years. In 1865, zebus from the Sudan were sent to the Jardin d'Essai (experiment station) of Algiers, and gave rise to hybrids of remarkable hardiness, which created much satisfaction among breeders. Traces of them can still be found in the coastal plain. Much later—some twenty years ago—M. Rabou of Bône introduced by accident, it is said, little Brahmins which gave even better results. This breed still exists and has furnished Tunisia with the best breeding-stock it possesses. Unfortunately, it is hard to obtain purebred bulls or cows, since they are more difficult to raise than are the grades.

The principal objection which can be made to the use of the zebu in our animal industry is that it is only a temporary expedient, and is not leading to the creation of a new breed. Nevertheless, it must be admitted that it is improving our cattle because an infusion of zebu blood considerably increases their hardiness. At present we see the most enthusiastic admirers of the Swiss and Tarentaise cattle seeking an alliance with the zebu, to give their breeds the quality of endurance which they now lack. The improvement of our cattle by zebus seems to me more practicable than the acclimation of pure breeds from Europe.

[3] C. L. Willoughby of the University of Florida College of Agriculture (Gainesville), who was formerly in charge of zebu breeding in Georgia, writes: "My understanding and my own opinion of the Georgia work was that it was rather clear that it would pay the Georgia people better to stick to other breeds, rather than waste their time and money on these Indian cattle. We found them bad-tempered and hard to handle, comparatively slow in growing, and poor beef animals and still poorer as milk animals."—The Editor.

THE CATTLE OF BRAZIL

Native Stocks Among the Finest in the World, but Ruined by Indiscriminate Cross-breeding—Introduction of the Zebu and Its Gradual Preponderance—Future of Live-stock Industry Jeopardized by Its Spread.[1]

José Maria Dos Reis

Director of the Model Cattle-breeding Farm of Uberaba, Minas Geraes, Brazil

BEFORE the introduction of the zebu, the bovine population of that rich portion of southern Brazil known as the Triangle of Minas Geraes was made up of diverse races which indiscriminate cross-breeding had brought to a degenerate condition. In spite, however, of this mixture of blood, under the breeding methods of the plains of Minas, Goyaz and Matto Grosso, there were formed, it may be said as a result of natural selection, races of cattle well suited for use in improving the country's live stock industry.

In the Triangle one particular race of local origin attracted the admiration of the whole world in the middle of the last century.

This breed, the ancestors of which are to be sought in old Portugal, is connected with the great Alemtejan race. Crossed with cows of the same race, already modified by Brazilian conditions, there was produced the bull known as the *bruxo* or *junqueiro* or *pedreiro*, or most commonly *franqueiro*.

Produced perhaps in the first place in the Triangle, the junqueiro cattle soon become better known as *Franca* cattle, largely through the influence of European zootechnists who took an interest in our stock-breeding.

In those days this favored zone of the Triangle of Minas, farther towards the interior of central Brazil, did not maintain, like Franca during the time of the emperors, commercial relations with the littoral, which the fame of this ancient city of São Paulo won for it. The Triangle was, then, in that epoch, a zone all but unknown, and when its breeders shipped out their cattle along with the Franca cattle, the junqueiro bulls lost this name in São Paulo, becoming known simply as franqueiro cattle, a name which passed into scientific literature.

CORNEVIN'S DESCRIPTION

It was, then, in Franca that Cornevin found the excellent breed which originated in Brazil and has maintained its specific characters down to the present time. He described it as "a type of great weight, heavy skeleton, long legs, long, coarse, red hair, with more or less pronounced tendencies to orange and canary-yellow; tail short and thick, with a well-developed, close switch, head large and flat, horns formidable."

According to this writer the franqueiro is related to *Bos primigenius*, which became extinct in Germany in the middle ages, while Nehring places it with the later *B. frontosus*, of the commencement of the present geological era.

For the rest, whether or not we admit the relations traced by these distinguished zootechnists, the franqueiro bull of the Triangle has its origin in the brachycephalous breed of the Iberian peninsula, originating in Portugal and introduced to this part of Minas in the last century by Col. João Francisco Diniz Junqueira.

But it is by no means the type which can be considered ideal for Brazilian purposes. There is yet much room for improvement.

[1] Translated from Chacaras e Quintaes, VIII, 1, 44, Rio de Janeiro, July, 1913.

It was necessary that man, keeping his own purposes in mind, should add certain characters to the genotypic composition of the breed, and modify others which were prejudicial to his purposes.

DEFECTS OF NATIVE CATTLE

The skeletal structure was too highly developed, at the expense of the muscular system, and the exaggerated horns prevented it from grazing on low herbs and in hilly country. When it was brought from the interior to the commercial districts nearer the coast, the breeders there immediately demanded that these prejudicial characters be done away with.

The goal, then, was to improve the breed from this point of view, and yet to conserve the high yield of milk for which it was noted. It was recollected, in a moment of inspiration, that the Amaro Leite breed of the Goyaz plains presented striking contrast to the franqueiro race, and it was believed that a cross might introduce a heterozygous equilibrium of characters, producing a race of grades which would be well worth breeding. The attempt was highly successful.

From this cross resulted the Caracú.

Such is the origin of this famous Brazilian breed, as understood by us here in the Triangle.

No other origin is possible. But we know very well that among those who have studied the Brazilian races of cattle, there is nevertheless a controversy over the origin of this breed. Some hold that it comes from the province of Ceará, having as its home the village of Acaracú, whose name in a corrupted form now designates the breed in question; others reasoning from similar premises, declare that it comes from the remote and ancient city of Kara-Kul in Central Asia, and that the progenitors of the Brazilian breed were brought from there in our colonial period.

THE CARACÚ A HYBRID

The positive fact, however, about the origin of this breed in our Brazilian ranges is that it resulted from a cross between the Junqueira and the Amaro Leite breed, which latter we call *curraleiras* and which, like most zootechnists in Brazil, we believe to be derived from the old dolichocephalous animals of Aquitania.

Thus it is that we possess in the Triangle these two types of cattle, which we believe to be the best in the world for the particular requirements of our native live-stock men. Nevertheless, this breed which our ranchers already possess, endowed with such excellent economic qualities, is yet susceptible of great improvement in the manner demonstrated by Bakewell and Colling,[2] since it cannot maintain itself and preserve its primitive characteristics without variation.

In our imprudent haste to improve it, we have allowed it to degenerate through cross-breeding with the Nile cattle brought to Rio Janeiro for the first time in 1826 and later spread through the fazenda of Sr. Azarias de Souza Dias at S. Antonio do Machado, Minas, and afterwards to Lavras do Funil and eventually to our own zone. Carried away by enthusiasm for the first generation of this cross, which showed the vigor common to all F_1 hybrids, our breeders thought the problem was permanently solved, ceased their efforts and went to sleep happy over the success of their undertaking.

In this foolish over-confidence, in their house on foundations of sand, whose impending fall they never foresaw, the fact that they were crossed with a heterozygous breed of doubtful origin never troubled them.

THE CHINA CATTLE

After the Nile, the China came to pour its blood into the mongrels already in existence. The arrival of this breed dates from 1855. Its Brazilian origin was a bull imported in that year by the Baron of Bom Retiro. According to a tradition reported by some, who believe this breed is really the zebu, it took its name from the fact that it arrived synchronously with a shipment of Chinese coolies whom the same baron had imported for work on his plantation. It is thus, then, with the crossing

[2] *i. e.*, by inbreeding.—The Editor.

THE CARACÚ, FAMOUS NATIVE BREED OF BRAZIL

Its origin is said to have been in a cross between two earlier native breeds, and it is here represented by a yearling bull. The caracú breed, although still capable of improvement, is considered by experts to be admirably adapted to its environment; it also lends itself well to crosses with improved beef breeds such as the Shorthorn and Hereford. In some parts of Brazil, however, it is being displaced altogether by zebu hybrids, which are preferred because of their vigor and hardiness, and ability to travel on foot long distances to market. Photograph from Murdo Mackenzie, São Paulo, Brazil. (Fig. 5.)

and recrossing of types heterozygous from their origin, and the mixture of mongrels of all sorts, that the patient and hard-working breeder on our ranges brought together the product of all this aimless hybridization and saw with extraordinary surprise that the beautiful F_1 type which once graced his ranges now played a very small part in the mixed cattle of the country.

The Brazilian cattle then entered on a period of free and rapid degeneracy.

Breeders began to take alarm, and tried to remedy the difficulty, which constantly increased.

In this period of anxiety, brought about by the existence of such serious evils, they again began, as at first, without aim, without definite plan or theoretical guidance, to attempt new experiments, certain that they would at once find a remedy for the trouble.

They took the route that seemed the easiest—that of introducing ameliorative factors. They forgot, in their stupor, the evil occasioned by past hybridization, and ran after Shorthorns, Devons and other fine types representative of the best European breeds.

The failure was enough to take the heart out of anyone.

Poorly equipped, by lack of knowledge of the genetic constituents of the breeds they were introducing; not having proper foods, not counting on the influence of environment, accustomed to the easy and economical conditions of breeding which existed in the huge herds of the interior, they assisted, disheartened, the gradual extinction

HALF-BREED ZEBU COWS AND HEIFERS

This herd represents the mixture of zebu and native Brazilian blood. Although thousands of zebu cattle have been imported to Brazil, they are rarely bred pure, but are crossed on native cattle to produce grades. The same attempt is being made in the southern United States, in order to give range cattle the advantage of the zebu's immunity from the dreaded Texas fever. Not only is the zebu immune to this, as far as is known, but it appears to be highly resistant to foot-and-mouth disease as well. It therefore offers valuable material for scientific breeding; but its full possibilities are not yet as well known as they should be, because little of the breeding hitherto done with it has been scientifically conducted. (Fig. 6.)

of these new arrivals, supposed to regenerate the herds depreciated by centuries of lack of attention and careless intercrossing.

NATIVE STOCK RUINED

The finest junqueiras, the excellent caracús that were able and are still able to regenerate the cattle industry of the Triangle, were dragged deeper and deeper into ruin by hybridization with half-bloods, with Niles and with Chinas. The latter breed according to some genetists is derived from the Albion; by others its name is derived simply from the old castilian word Chino or China, which means mongrel; by still others, its domain is said to be ancient Asia.

What, then, was the value of the appearance in this *mare magnum* of misfortune, of admirable individual types of these beautiful and useful national breeds, if stockmen did not know enough to utilize them by selection and line-breeding? In the greed with which they sought salvation, they looked only for a remedy with immediate effects. Selection was slow, and perhaps they did not wholly believe in the extraordinary results accredited to it.

The day of native cattle was about over. Those fine representatives, junqueiras, caracús, curraleiros, etc., inured to the environment, with good and fixed qualities which could be transmitted through successive generations, were relegated to the background and gave place to the zebu, which, like the Nile and the China, reigned in majesty in the vast and lush pastures of the territories of Minas.

Without the beautiful and useful qualities which ornamented our national breeds, the zebu conquered them, for a time, principally by its wonderful hardiness and its aptitude in acclimating itself to our native ranges—as if 400 years of abandon were not enough to prove that our native stock had such a hardiness, too!

All native stock in the Triangle, which has not yet been mixed with Indian blood, is heavy, healthy, strong in the yoke and resistant to diseases, gentle and rich in milk. In spite of the neglect to which they have been subjected, it is not rare to find specimens of our native breed—that breed which R. Endlich has called the finest cattle in the world—with a weight of 100 arrobas (*i. e.*, 3200 pounds), and magnificent caracús, such as beat the record at the exposition held in Uberaba, where hardly fifteen specimens of this breed, raised locally, were shown, as against 400 Indian cattle, coddled in succulent pastures under the vigilant eyes of their owners.

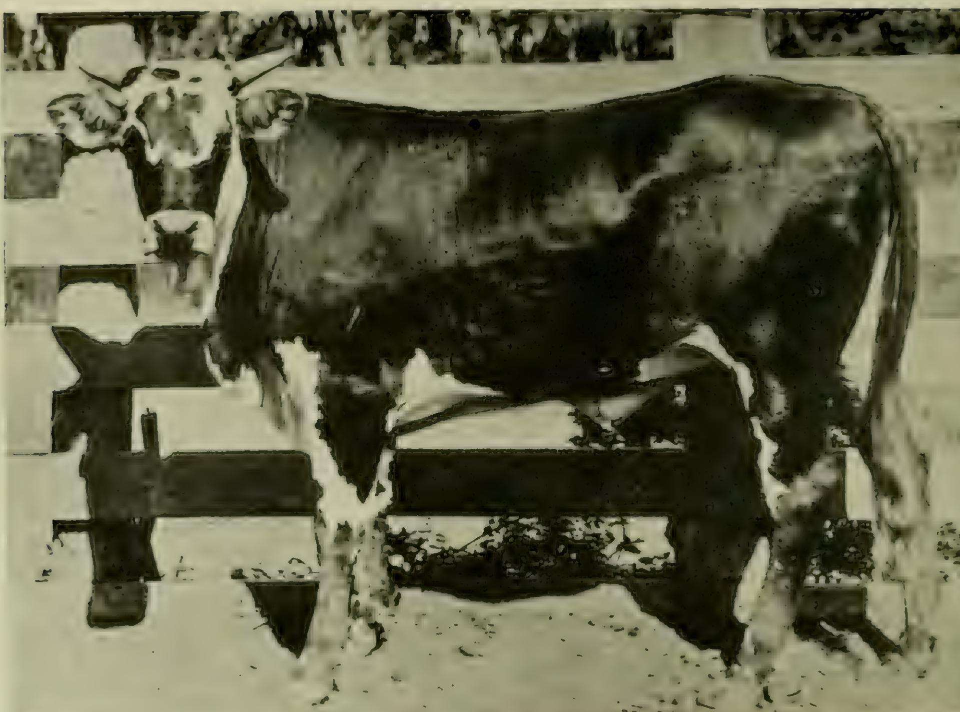
INTRODUCTION OF THE ZEBU

Aside from weight, the caracú is reputed an excellent worker, and is considered to be the best bull for work—superior to the zebu. However, the breeder of the Triangle, in spite of the unhappy experiments made with the best European races and the evils occasioned by crossing with Niles and Chinas, as we have already seen, disregarding his own home breed, introduced for the first time in 1889 representatives of *Bos indicus*, the idol of the banks of the Ganges, to the pastures of the future stock breeding zone of Minas Geraes.

It must be admitted that the crossing of this race has brought a certain prosperity to the breeding industry in the Triangle of Minas, since the grades have been sold for good prices. Forgetting, perhaps, the results obtained with crossing other breeds in the past, the breeders, encouraged by the good returns of this new venture, think that they have attained the desired end in regard to the perfecting of a breed for local use, and are now gathering the first fruits of the harvest like the victors of a crusade.

It is yet too early for this.

Questioning one of the largest breeders of this region as to the reason for himself and other breeders preferring the zebu to any other race, he replied as follows: "This region being essentially one for stock raising, and our ranges being occupied by various breeds of milch cattle in a state of degeneracy, we hope to improve the present state of affairs through crossing. We prefer to attempt this by means of the zebu, because we



ZEBU-HEREFORD CROSS IN TEXAS

This half-breed heifer, weighing 1000 pounds at 12 months, was bred on the ranch of A. P. Borden, Pierce, Texas, and allowed to graze all summer on a range infested by the ticks which carry Texas fever. She was never dipped or protected against ticks in any way, but at the end of the summer showed no trace of infestation. It is such cases as this that have led geneticists to foresee in the zebu the foundation of a new breed of cattle for the southern United States. Photograph by the Bureau of Animal Industry, U. S. Department of Agriculture, November 18, 1911. (Fig. 7.)

have proved that the grades produced by this cross possess the following characters: weight, facility of acclimation, hardiness and fecundity.

FECUNDITY OF THE ZEBU

"We have observed that the descendants of the pure blooded zebus imported in 1889 breed with facility in our ranges, even in seasons of drought, resisting all sorts of weather.

"The zebu bull allowed to run loose on the range will produce from sixty to seventy calves, in a period of four to five months. The heifers rarely fail to produce their first calves at three years of age. We have had a grade cow give birth to two calves inside of ten months and six days. The calves are strong, like all crossbred cattle, and the rate of mortality, compared to that of the breeds formerly raised here, is extremely low.

"The development of the grade and its facility for fattening are such that steers 3 years old are ready for butchering and are preferred to any other race by everyone who handles them, from the buyer on the ranch to the butcher who offers for them the highest market price. At 5 years the hybrids average from 650 to 700 pounds in net weight."

Two particular races of the zebu are preferred; the Nellore and the Gujarat; the former with small ears and the latter with ears well developed.

In this latter, the preference is interesting.

For all the grace, beauty and weight of the Nellore race, it is always worth

A STRANGE ZEBU HYBRID

Mestizo bull in the Phillipines; a cross between zebu bull and Batanese (native) cow. The front half of the animal is wholly zebu in character, the dewlap and hump, which are the particular property of the Indian breeds, being represented in perfection. The hinder half of the animal is wholly characteristic of the native stock of its mother (note sheath and rump). Photograph from the Bureau of Agriculture, Manila, P. I. (Fig. 8.)

less money than the angular progeny of the large-eared Gujarat.

Zootechnists, who have transformed the internal machinery of cattle in order to make them yield more profit to their owners, have entirely ignored that common appendix, the ear: yet it is the criterion by which admirers of the zebu rate the value of the animal—its length or shortness determines the high or low amount of the price.

The breeders of this race of cattle value an ear more highly than the juicy steak of a short-eared caracú.

They say that the zebu without large ears is not a zebu, and the native of the interior advances that reason, as he refuses to buy it.

MENDELIAN SEGREGATION

Among the breeders of this municipality, it is a matter of common observation that native characteristics are wholly bred out and zebu characters entirely dominant in hybrids after the fifth generation. In the fourth generation they get a type which they call purified, resulting from a cross of a pure type with a seven-eights cow. The crossing of a purified with a pure blood is that which they accept as a pure national type, the "Zebu of Minas."

However, at present this race is not yet established. Whether the breeder breaks it up in the sixth generation by crossing back to pure zebu, not realizing that the introduction of this pure-blood anew is equivalent to another hybridization; or whether the *Bos indicus* undergoes actual degeneration; the fact remains that the pure Minas race of zebu has never yet been fixed.

The latter explanation seems more acceptable, because the renovation of

blood in this breed is frequent. Perhaps the breeder does not succeed in fixing a race of definite type such as we have just described, because he is obliged constantly to breed a certain saleable type of cattle, and therefore resorts to constant out-crossing to get it, bringing in new Indian blood in every generation. The result is that a distinctly local type of zebu is never fixed, because it is always upset by a cross back to the imported stock.

The herds and herds of breeding stock coming steadily from India to the ranges of Minas prove this assertion.

The advantageous cross is the commercial cross: that is, to sell and resell the hybrids for slaughtering. Crossbreds of this type range from one-half to three-fourths blood; they are the heaviest hybrids. Beyond this cross, the Indian rapidly loses his weight.

The contrast here between *Bos indicus* and *B. taurus* is striking. While in the latter, greater weight, precocity, etc. are gained by selection, in the former a steady loss of weight takes place, together with an extraordinary reduction in height.

THE ZEBU PREPOTENT

The zebu originates in an ancient, thoroughly fixed race. Due to the hereditary potency of the ancient Indian race, the types produced by its cross on the native cow faithfully reproduce all the characteristics of the foreign race.

The zebu is an absorbing race, and by this property has caused the complete disappearance of the Brazilian race in the fifth generation.

Under these conditions, scattered here and there, as we find them, throughout Brazil, by the commerce in halfbloods, for butchering and breeding, and with herd after herd coming from India—it is certainly desirable that the government should give serious attention to the study of this type of cattle so that in the future we may not find our hands full of difficulties, even greater than those offered by our old race of mongrels.

In the municipality of Uberaba, which comprises barely 9,314 square kilometers of the vast zone of the Triangle, and 7,451 square kilometers of this under cultivation to the native grasses *jaragua* and *gordura*, the number of cattle was in the years 1908-9, according to Dr. H. de Araujo Pontes, 83,043 head, of which 1,012 were pure zebus, 37,174 zebu hybrids, 12,477 caracús, 30,913 Chinas, 1,378 curraleiros and 186 Turinos.

In twenty-four years—the time that has elapsed since the introduction of the zebu—one can easily see that in a small and insignificant part of the interior region, this breed has greatly increased in number and the native breeds have lost ground. From this one can easily understand the absorbent power of this breed, which if it continues as it is now going, in a short time will give us not a better race, but a new race, to replace the old one. We will have changed the race, perhaps, for the worse. There are no scruples about this breeding experiment.

The zebu has been crossed with every one of the hybrid races of our cattle which I have referred to.

In this indiscriminate hybridization, to right and to left, bulls constantly arriving from the orient ostensibly as purebloods, but without bringing any certificate of registry, are being bred to every grade of our own hybrids.

DANGER TO THE INDUSTRY

It can be verified from this that, in spite of the relatively short time since it was introduced, this breed will lead more quickly than any other to the complete ruin of our native stocks, through degeneracy, if energetic precautions are not taken to forbid breeders to make such crosses.

It is a great evil which we must avoid, and one which, unhappily, is increasing, speading to the far-away prairies of Goyaz and Matto Grosso and even to Rio Grande do Sul, where only a year ago 1,500 breeding animals of all grades of blood were exported from one municipality.

Even with pure-blood bulls brought directly from the province of Gujarat in India, degeneration is manifest in the third generation, to such an extent that breeders are constantly obliged

to change the leadership of their herds.

Imagine the results of crosses between the hybrids!

The products of the first cross between zebus and junqueiras or caracús are the best types. They are strong, heavy animals with great hardiness under all conditions, thrive on any kind of pasture and are excellent under yoke.

As to the quality of the beef, current opinion is that it does not lend itself well to the dried-beef industry, because its tissues do not contain as much fat as do those of the caracú and other good races.

The flesh of the zebu is fibrous, particularly when there is only a small amount of native Brazilian blood in the crosses.[3]

For this reason, and also because of what has previously been said, the flesh of the Indian cattle is of poorer flavor than that of our breeds—especially that of the franqueiro race, which R. Endlich claims is the best producer of high grade beef. The zebu has not a large skeleton—particularly hybrids with Nellore blood. Steers from the crossing of this race with the two superior native races at four years attain an average weight of 700 pounds. The hybrids of greater proportion of zebu blood are much lighter—an indisputable proof of the speedy degeneracy of *Bos indicus*.

LOSS OF MILK YIELD

In general the crossing of the zebu with our cattle makes the latter lose a large part of its milk producing qualities. The first period of lactation of the hybrid zebus is at the most ninety days after the birth of the calf; from then on, due to the new gestation, the cow commences to diminish in milk considerably, having weaned her calf at six months. As for the annual production of milk, it is difficult to determine it in these grade cattle, because of the reasons already set forth and because zebu breeders in the Triangle pay little attention to matters connected with dairying.

The hybrid zebus in general are bad milkers, and rarely allow themselves to be milked. They are wild, and if tamed at their first calving, soon lose this domesticity and have to be tamed again at each calving.

This is a laborious proceeding which completely prevents dairying if the cattle are of Indian blood.

Many hybrid zebus have the yield of milk so little developed that they are unable to raise their own offspring. This is, then, outside of the defects such as wildness, rapid degeneration and lack of milk, a serious defect that this race is instilling in our native cattle.

We must take strong measures to oppose this steady ruin of our native cattle, which is fast becoming a race of scrubs through indiscriminate cross-breeding without scientific guidance.

It is an interesting phenomenon.

Withal, if the crosses between grades should result in a fixed race, without the inconveniences of frequent reversions and without having to commence breeding operations from the beginning, all over again, every few generations, the Indian cattle would be good types both for commerce and for beefing, particularly having in view the great distances that separate the pastoral zones of Goyaz and Matto Grosso from the littoral, where the cattle are slaughtered.

But the solution of this problem seems to us very difficult in such a manner—particularly with this stock.

The reasonable, certain, and economic solution is that which our government is trying to give to the case—founding establishments to carry on systematic selection with our marvelous native races of cattle.

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[3] Murdo Mackenzie of the Brazil Land, Cattle and Packing Co., São Paulo, writes me: "A characteristic of the zebu is that it produces almost entirely dark meat with little or no fat mixed with it, and this is the kind of beef the natives prefer, but it is not suitable for exporting to Europe or America. You will notice from the conformation of the zebu's head that it is lacking in brain development. It is narrow between the eyes and has a long, narrow, keen head and face, which shows that it has not the brain development of either the Shorthorn, Hereford or the other beef breeds. The natives of this country are fond of the zebu hybrids because they are good travelers, and as nearly all of the cattle are transported on foot, this seems to be quite a factor to their minds. When the cattlemen of this country commence transporting their cattle by rail rather than by foot they will see the necessity of breeding cattle for better beef."—The Editor.

XENIA IN FOWLS

Experiments to Determine Whether Cock Has Influence on Color and Form of Eggs Laid by Hens to Which He Is Mated—Belief Seems to be Without Solid Foundation.

A Review of Some Recent German Work

XENIA is the name given by Focke in 1881 to designate a curious feature of hybridization in plants: the direct influence of foreign pollen on the seed produced. Popularly, its meaning has been extended to describe any direct influence on the fruit as well as the seed. Such influence has been a part of farm lore for centuries. The farmer has attributed the bad quality of his watermelons, for example, to the fact that they were pollinated by pumpkins grown in an adjoining field. With the increase of knowledge of what was actually accomplished by pollination, and what the actual process of reproduction was, it became clear that most of these beliefs were little better than superstitions. Geneticists decided that the watermelon could not be deteriorated by pumpkin pollen, because that pollen could have no effect on the fruit resulting from the flowers it pollinated. What actually happens is that the germ-cell of the pollen grain unites with the egg cell of the other parent, and the essential parts of the two lie side by side in the resulting seed, not even fusing. It is not until this seed is planted, grows and matures its own seed, that the original heredity-stuff of the parents is shuffled, recombined, and given a chance to express new characters or make combinations of old ones.

Pollen, therefore, in the nature of things, cannot ordinarily have any *immediate* influence on the fruit produced. But certain exceptions—reported for two centuries by farmers and breeders, first examined by Focke, and later well attested by many observers—have been found, the best example being in maize. When a race of white maize is crossed with a variety bearing black ears, the seeds produced should all be white. The black father would not show its influence until these seeds were planted and produced ears in turn. But xenia interferes, so that the seeds of our original pollination, instead of being white, actually show the effect of the black parent—they will be splotched or, in many cases, wholly black. Speaking figuratively, xenia seems to leave the pollen parent always one lap ahead in the race. The parental generation shows characters that would not ordinarily be expected until the F_1 generation; the F_1 generation shows characters that would not ordinarily be expected until the F_2 generation; and so on.

XENIA IN PLANTS

Here was a mystery that puzzled plant-breeders for some years. Similar phenomena were found in rye, buckwheat, and other plants. The mystery was finally cleared up by Nawaschin and Guignard (1899) and Webber, De Vries and Correns (1900), who found that it could be explained very simply from a knowledge of the cell mechanism. There are two nuclei in the pollen cell and two in the egg cell. The principal nucleus of the one unites with the principal nucleus of the other to produce the embryo; the secondary pollen nucleus unites with the secondary egg nucleus and produces the endosperm or starchy part of the seed. The immediate influence of the pollen parent is therefore naturally to be expected in the endosperm, and will be visible, in general, whenever the differences between the two parents are of a striking nature—black and white, in this case. In ordinary pollination between plants of like characters, an influence is produced by the pollen parent on the endosperm, but is

not of a nature to show itself. The phenomenon of xenia in the plant world, then, is a perfectly simple and natural one, is dependent on the double fertilization described above, which occurs in all flowering plants, and may be expected to be visable whenever the differences between the two parents are of a nature favorable to its observation.

There is always the hope in genetics that what is found to be true of one section of the organic world will be found to hold good in all. If xenia occurred in plants, it or something like it might be expected in animals. Accordingly, phenomena of similar nature in the animal kingdom were sought.

An attempt was made to connect xenia with telegony,[1] but the analogy does not seem to be very close. There is, in fact, a fundamental difference, for in xenia we have an actual union of two cell-nuclei, while the supposed effects of telegony have been accredited to an interchange of blood, or some more mystical and less definable cause. Telegony is now dead, in scientific circles, while plant xenia is more alive than ever.

If it could not be traced in mammals, it might be traced in fowls. It has long been believed by some people, though not by most naturalists, that the eggs laid by a hen are influenced, as to size, shape, color, by the cock with which she is mated. An attempt was made on numerous occasions to show telegony in this connection, but the case was very weak. Then it was decided, by a certain set of investigators, that here was the long-sought case of xenia in the animal kingdom.

From this standpoint the question has been debated with considerable warmth during recent years, principally among German biologists. Obviously, there are two parts to the discussion. First, does the alleged influence of the cock on the appearance of the hen's eggs really exist? If it does not, there is an end of the dispute; but if it does, we can go one step farther, and try to explain it. If it exists, is it a phenomenon similar to xenia in plants, or must it be explained in some other way? The latter question may be set aside until we have considered whether there is any evidence of this paternal influence on hens' eggs.

XENIA IN POULTRY

The first observation on record by a man of science seems to go back to W. von Nathusius (1867) who reported the case of a supposedly pure bred hen, of a breed that always produced white eggs. She was mated to a cock of the old Cochin China breed, which produces brown-shelled eggs, and some days later she began to lay eggs with yellowish shells. This influence disappeared very gradually; even after months an occasional dark egg appeared.

Such evidence, of course, counts for little with the modern biologist, who has become more critical than a jury lawyer as to what he accepts. There were a dozen ways in which the facts, if such they were, might be explained, and as there had been no "control" of any kind, there was no means of knowing that the yellowish color of the eggs was not due to something in the hen's food, or to any one of numerous other exterior or interior causes, quite independently of the Cochin China cock. So an attempt was made to gather evidence of greater "evidential value" by carefully planned experiments.

Plymouth Rocks, a breed well known to lay brown-shelled eggs, were chosen by Professor P. Holdefleiss[2] of the University of Halle for this purpose, and mated with a Leghorn cock, whose breed produces eggs of a pure white. "The eggs showed a series of colors from dark brown to white. Some of the medium brown eggs showed white flecks. Some of the dark brown were

[1] The principle of telegony "is that females are *impregnated* by the first males to which they are bred, so that all their subsequent offspring, regardless of their actual father, will show influence of the first male." See "Telegony," by Dr. Etienne Rabaud, Journal of Heredity, V, 9, 389-399, Washington, D. C., September, 1914.

[2] Holdefleiss, P., in Ber. aus dem physiol. Lab. u. der Versuchsanstalt d. landw. Inst. d. Univ. Halle, 20 Heft, 1911, S. 93-111; also in 25 Flugschrift d. D. Ges. f. Züchtungskunde, Berlin, 1913.

EFFECT OF XENIA IN GRAIN OF CORN

This grain of maize was produced by a pure white strain, which had been pollinated from a red variety. In general pollen has no *immediate* visible effect on the characters of the resulting fruit, but it is now known that it does produce an effect on the endosperm, or starchy part of the seed. This effect, which is known as xenia, can be easily seen in the dark-colored blotches and splashes sprinkled over the seed, just under the translucent, seed-coat. (Fig. 10.)

perhaps unfertilized." Holdefleiss had the courage to enunciate the following conclusions:

"1. The color of egg shells shows, after fecundation of the hen by a cock of some breed other than her own, the influence of the paternal strain; there is, therefore, evidence of xenia.

"2. The shell of a bird's egg is not exclusively a product of the maternal parent, but is also acted on by the cells formed after fertilization. The material which goes into it, however, is furnished by the mother's body.

"3. The color characters of the egg shell segregrate in the following genera-

tion (F_2) according to the 'pea type' of Mendel's law, in the proportion 3:1."

EVIDENCE IS EQUIVOCAL

As Walther, who critically reviews the evidence, says, "The conclusion in this last case does not fit the facts very closely. What, in the first place, is the 'pea type' of heredity? It is that method in which, at the crossing of organisms differing in *one* pair of *non-blending* characters, the first hybrid generation shows a complete concealment of one (the recessive) character by the other (the dominant one), while the second generation shows the proportion of three dominants to one recessive. And just what results did Holdefleiss actually secure? In the first generation (to which he considers the shells of the eggs belong, from which the hybrid birds of the first generation will be produced) *both* characters of the parents (*i. e.*, brown and white) appeared, together with an intermediate form which had not previously existed. For the purpose of demonstrating his xenia he picks out these intermediate eggs, which are impossible in the 'pea type' of heredity; for the purpose of demonstrating the pea type of heredity, he depends on the brown eggs, which he himself admits are of no significance for xenia, because likely not to have been fertilized. In the second generation (by which he designates the eggs laid by this first generation), instead of the *brown* and white eggs in the proportion of 3:1, which calculation on the basis of Mendel's 'pea type' of inheritance required, he got two brown, 119 brownish or intermediate, and forty white; whence he concludes that 'brown showed itself to be the dominant character.' "

If this is the fate of Holdefleiss' third proposition, it is evident that his second one is on soft ground; and the first one, that xenia actually did exist, is far from proved, considering the number of possible explanations that might be made.

Domestic fowls are not an ideal material for genetic experiments, because of the fact that they are all more or less hybrid in origin, and their appearance gives little idea of what their germ-cells actually contain. Armin von Tschermak,[3] professor of physiology in the Veterinary High School of Vienna, attempted to throw light on the question by breeding canaries and finches, closely related species of wild birds which might be expected to be purer in genealogy. English or Harz canaries were mated partly with males of their own kind, and partly with males of five different wild species. As a control, unmated canaries were allowed to lay eggs that had not been fertilized at all. The results of the experiment, as described by its author, may be summed up as follows:

Changes in the form of the eggs, as a result of paternal influence, could be seen in only two cases, and these are questionable; therefore no weight is attached to them.

CHANGES IN PATTERN

There was no change in the ground color of the egg shells. The pattern is made up by two pigments; light brown and dark brown. Alterations of the light brown pigment were slight, but in the direction of paternal influence. The dark brown pigment, on the other hand, showed modifications that cannot be questioned. "They are so clear, that an experienced eye can tell at a glance what the paternal species is, in each case. . . . As to the occurrence of xenia in the coloring of bird's egg shells, there is no longer room for any doubt. . . . The hybridization, in the cases here analyzed, has exerted a specific influence on pigment formation in the egg shell."

The unfertilized eggs of unmated female canaries were then compared with the fertilized eggs of female canaries mated with males of the same species. The former were found to be slightly smaller, and almost lacking in

[3] See Biol. Centralblatt, 30 Band, 1910, S. 641-646 and Arch. f. die gesamte Physiologie, 148 Band, 1912, S. 367-395. The author is a brother of E. von Tschermak, the distinguished Austrian plant-breeder who with Correns and De Vries was one of the rediscoverers of Mendel's work, in 1900.

pigmentation. This gives the experimenter further ground for the belief that the formation of pattern on the shell is connected with and influenced by fertilization.

ONE SOURCE OF ERROR IN I

Photograph by the Bureau of Animal Industry, U. S. Department of Agriculture, sh
during recent years show that the eggs of any individual hen tend to become a
believed, is likely to be a dwarf, such as is shown at the right in the above photogr
however, the eggs of any individual fowl usually vary only slightly from a certain a
matter determined by heredity. But the wide range of variation in weight of egg
one who is conducting experiments on the subject make constant use of trap-nests

Assuming for the moment that this conclusion is well founded, that we actually have xenia or something like it in birds, how could it be explained? Whichever way we turn, we run against generally accepted principles of biology that we can not avoid: it is this fact as much as the lack of adequate experimental evidence, no doubt, that makes the average biologist incredulous about the whole idea. Two possible means of explaining an influence of the male in this connection are suggested by von Tschermak. The first he calls an "intra-oval xenia-reaction," meaning that the effect of hybridization on the egg shell is an effect produced by the embryo—that is, in the last analysis, an effect of a single sperm. The second method is "extra-oval xenia-reaction," which supposes that the effect is produced by the influence of the whole quantity of sperms on the maternal uterus.

The first hypothesis seems to von Tschermak to be simple and acceptable, but most readers will probably share the feelings of Walther, who remarks: "An influence that goes in a very short time, partly through the yolk and always through a surrounding body of unorganized albumen, through the entire shell, and demonstrates its presence on the very outside layer of this shell of lime and—this is a point that I think has not been sufficiently emphasized—only on this outside layer of shell: certainly no one can form even the slightest conception of how such an influence could originate or exert itself."

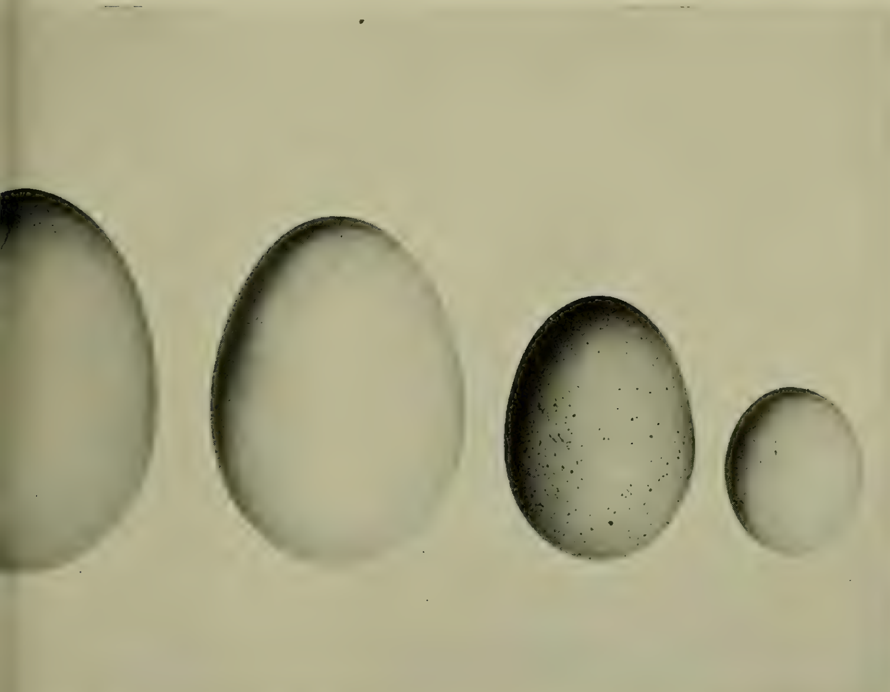
To most biologists, the second hypothesis will seem little better. There is, however, a small amount of evidence now accumulating,[4] which indicates that the sperms which do not play any direct part in reproduction may survive for a time and possibly exert some

[4] See Kohlbrugge, J. H. F., in Ztschft. f. Morphologie u. Anthropologie, 12 Band, 1910, S. 359-368, and in Arch. f. Entwicklungsmechanik, 35 Band, 1912, S. 165-188.

influence of some kind on the maternal organism; and Walther expresses himself as willing to entertain such an idea as a working hypothesis, at least.

CONTRADICTCRY EVIDENCE

But perhaps this discussion of how xenia takes place in fowls is really beside the mark—because it may not really take place at all! Until von Tschermak's experiments with canaries have been substantially repeated by other investigators, and have withstood a critical examination by some one able to speak with authority, this small amount of evidence can not be given great weight. It would not be entitled to very much consideration even if it were uncontradicted; but it is in part contradicted, and directly contradicted, by experiments of Professor A. R. Walther of Giessen,[5] which appear to have been made with a great deal of care, and to have been analyzed by sound mathematical methods.



'ERIMENTS WITH HENS' EGGS

ıg range in size of eggs from a single flock of hens, all of the same breed. Experiments e smaller, as she approaches the end of her laying period; and the last one, it is generally : the small size of "pullets' eggs" is also a matter of common knowledge. On the whole, ıge weight, and the experiments of the Rhode Island Station indicate that this weight is a ı a flock of one breed, graphically shown in the photograph, renders it necessary that any l records—otherwise he is likely to draw some wholly erroneous conclusions. (Fig. 11.)

Walther's conclusions are based on examination of 630 eggs laid by thirteen hens. His method of operation was to cross races differing not only in egg-shell color, but in size—that is, bantams and ordinary fowls. Every egg laid was incubated, and if it was found to be infertile, it was thrown out, a possible source of error thus being avoided. As was pointed out above, Holdefleiss' results are of little consequence as a proof of xenia, partly because there is reason to believe that many of the eggs he examined had not been ferilized at all, and from such eggs it it is obvious that no evidence about xenia—the influence of fertilization—could be expected. They might, however, be covered by von Tschermak's second hypothesis's described above.

The points taken into consideration by Walther were (1) the weight, (2) the shape, (3) the glossiness, and (4) the color of the eggs. It will not be worth while to quote Walther's statistics, but his own conclusions may be indicated.

1. It could not be found that the cock produced any effect whatever on

[5] Walther, Adolph R. Ueber den Einfluss der Rassenkreuzung auf Gewicht, Form, Glanz und Farbe der Hühnereier. Landwirthschaftliche Jahrbücher, XLVI, Heft 1, S. 89-104, Berlin, 1914.

the weight of the individual eggs laid by the hen. Such slight changes as were noticed can be explained by the fact that the weight of a hen's eggs tends to diminish toward the end of her laying season.

2. It could not be found that the cock produced any effect whatever on the form (proportion of length to breadth) of the eggs. Walther says that the weight and length of an egg are very closely correlated, so this result is only what would be expected from result No. 1.

3. The glossiness of surface of the eggs did not seem to be at all affected by the cock. This is not such a critical case as some of the others, because the differences in glossiness of the eggs of the pure races used in the experiment are not so great and sharply distinguished. As far as it goes, however, the examination of this point utterly fails to show any trace of xenia.

4. As to the influence of the cock on the color of egg shells, the experiment was not entirely conclusive. It was started with another purpose in mind, and sufficient care was not taken to choose breeds of fowl that were sharply distinguished in the color of their eggs. The results, such as they are, tell against rather than for an influence of the cock on the color of the egg shell, but Walther does not claim that they are final.

THE CONCLUSIONS

In conclusion, Walther says: "The study of the question whether the male bird is in a position to influence the egg shell characteristics in the direction of those that mark his own breed or species, was taken up to determine the accuracy of the investigations previously mentioned, purporting to show that xenia occurred in the animal kingdom." As far as Holdefleiss' results are concerned, Walther thinks they are hardly worth considering. As for the results from von Tschermak's crosses of canary species, Walther says, "My own results have contradicted them, as far as size, shape and glossiness of the eggs is concerned, showing not the slightest trace of influence on the part of the cock. For the question of influence on the *color* of the egg shell, my researches unfortunately are not in a position to throw much light. I think that both these alleged cases of xenia in birds' eggs are from every point of view utterly unsafe grounds for drawing any sweeping conclusion."

Few biologists would be likely to dissent from Walther on this point, that no sweeping conclusions should be drawn from this evidence; and Walther's own results must share the same fate. Von Tschermak's experiments with canaries must be regarded with respect until they are contradicted or explained away, but the evidence of xenia in poultry is certainly not adequate. American poultry breeders do not, on the whole, entertain a belief in xenia in their flocks, and as far as the present evidence is concerned, their skepticism seems to be justified. The question is a recent one, and much work may yet be done on it, but until such work is done, xenia in fowls must be considered an open question, at most.

Barred Pattern in White Fowls

In the note at the bottom of page 149, Journal of Heredity, April, 1915 (Vol. VI, No. 4), it is stated that "Further analytic breeding proves that this barring is carried in the germ-plasm of the White Leghorn, not the White Plymouth Rock." The last line should have read, "of the White Leghorn as well as the White Plymouth Rock."

MORE "EUGENIC LAWS"

Four States Consider Sterilization Legislation and Nine Contemplate Restrictions on Marriage—None of Proposed Laws Satisfactory from Eugenic Viewpoint

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LEGISLATION is still, in the minds of many people, a panacea for all the biological ills of the nation, and the past winter has seen another crop of proposed "eugenic laws," of a character which the experiences of recent years would lead us to expect. Most of the measures which the public hails as eugenic have nothing to do with eugenics, and some of the measures that bear on eugenics bear in the wrong direction. The popularization of the science of eugenics has suffered in the past in two ways which are direct antitheses. On the one hand it has been declared a fad, the dream of the idealist, the impractical propaganda of the mentally unemployed, while on the other hand it has been made the refuge of that species of crank who always welcomes the new and unusual, and a cloak to be thrown about weak legislative measures requiring the sustenance of popularity. Eugenics is a science. It is a fact, not a fad. It is a means for the continued betterment of the race stock and the physical and mental uplift of mankind in general. In order to achieve success, a knowledge of its principles must be disseminated and it is important that those interested in the furtherance of eugenics should understand the exact nature of these measures in order that, if they see fit to favor them, they may not do so under the impression that they are furthering the cause of eugenics. With the assistance of the editor of the Journal of Heredity, there has therefore been prepared the following digest of bills advertised as eugenic, which, as far as we know, are now pending in the several States of the Union.

Bills for the sterilization of certain supposedly undesirable classes of citizens have been introduced in the legislatures of four states. These, if rightly framed and properly administered, would have a eugenic value in cutting off defective streams of germ-plasm. They will be considered first.

The Nebraska bill (House No. 15) provides that the Board of Commissioners of State Institutions shall appoint two physicians to be known as the board of examiners of epileptics, feeble-minded and other defectives. Their compensation shall be $10 a day while they are actually engaged in this work, and their duty shall be to examine into the physical and mental condition and record and family history of the feeble-minded, epileptic and other defective inmates of the several State hospitals for the insane, State prisons, reformatories and charitable and penal institutions. If it shall be the judgment of this board that procreation by any such inmate "would produce children with an inherited tendency to crime, insanity, feeblemindedness, idiocy or imbecility and there is no probability that the condition of any such person so examined will improve to such an extent as to render procreation by any such person advisable, or if the physical or mental condition of any such person will be substantially improved thereby, then said board shall appoint one of its members to perform such operation for the prevention of procreation as shall be decided by said board to be most effective." Court procedure is made necessary, however, before the operation is actually carried out.

Section 4 of the bill provides that, "Except as authorized by this act, every person who shall perform, encourage, assist in or otherwise permit the performance of the operation for the purpose of destroying the power to procreate the human species or any person who shall knowingly permit such operation to be performed upon such person unless the same shall be a medical necessity, shall be guilty of a misdemeanor."

BILL ONCE VETOED

Those familiar with the recent history of restrictive eugenics will observe that this is almost identical with the bill which passed the Nebraska legislature two years ago. The only changes are that the former bill included criminals among the classes which might be sterilized, and made the offense in section 4 a felony instead of a misdemeanor, a penitentiary instead of a jail offense, so to speak. Governor John H. Morehead in vetoing the former bill on April 14, 1914, said: "This act is so far-reaching in its consequences and so intimately related to the social life of mankind, that legislative action should not be taken thoughtlessly or hurriedly. This proposed legislation is new and practically untried; at best it is only an experiment and it seems more in keeping with the pagan age than with the teachings of Christianity. Man is more than an animal." The governor further remarked that he thought the act might be unconstitutional, and pointed out, "There is no valid reason why this should be made to apply to wards of the State. These wards are under the care and control of superintendents appointed by the State, the different sexes are segregated and the danger sought to be obviated by this act is already well guarded against."

If the sexes are properly segregated in Nebraska institutions, and detained until they have passed the reproductive period, if not for life, then the writers agree with Governor Morehead's action in vetoing the bill, although they do not agree entirely with his reasons for doing so. The newly introduced measure applies only to the feebleminded, epileptic and defective wards of the State, omitting criminals as such. But Governor Morehead says these wards are already effectively segregated. The proposed sterilization measure therefore seems unnecessary, and should not be passed.

Several weaknesses in the measure might be pointed out; the writers will refer only to section 4, which would make it a misdemeanor for anyone to perform a sterilization operation, except on a ward of the State. In his veto message, the governor said, "I am heartily in favor of the provisions of section 4 of this act and would be pleased to sign a law making it a felony for any person to perform any operation for the purpose of destroying the power to procreate the human species and making it a felony for any person to permit such an operation to be performed." In the judgment of the writers, this attitude, which is unfortunately widespread, is a menace to eugenics. If the interests of society are best served when a man with given characteristics, in a state institution, is sterilized, then the interests of society will be served equally well when a man with the same characteristics, outside a State institution, is sterilized; and certainly no one will contend that all the cacogenic stock in the state of Nebraska, or any other State, is within the walls of the State institutions. It should be possible for any adult person in possession of his faculties to submit to the operation of sterilization if, in his judgment, it is to the interests of the race that he should not procreate. The Nebraska bill would legalize sterilization when it is for the physical well-being of the individual: is the physical well-being of the race less important than that of the individual? Cases constantly occur where high-minded persons seek sterilization in the interests of the race, knowing themselves to be carriers of defects or anti-social traits; it is to the interest of eugenics that such cases continue to occur. As for the low-minded persons who may seek sterilization to avoid the economic or social consequences of parenthood, it is certainly not to the interests of eugenics

that people of that character should leave offspring who are likely to resemble them.

From the standpoint of eugenics, therefore, we think it would be a mistake to pass a law which would make sterilization outside of State institutions absolutely impossible. No doubt the practice of it should be properly safeguarded, but that is a very different thing from branding it as a felony. It might be possible to have cases proposed for sterilization reviewed by a State board of experts, in order that quacks should not take advantage of freedom from restriction to work irreparable harm to credulous or cowardly young persons. Eugenists can be counted on, we believe to support any honest attempt of a State to find a means whereby sterilization can be properly controlled and directed, but we cannot countenance measures which will stigmatize eugenic asexualization as a crime.

WASHINGTON LEGISLATION

The State of Washington has had, since 1909, a law providing that courts may order the sterilization of habitual criminals and extreme sex-offenders. It is, as H. H. Laughlin, Superintendent of the Eugenics Record Office, says, "A purely optional and punitive statute that should be recast into an operable eugenical measure." An attempt was made to do this in 1913, but failed. Another bill was introduced in January of this year (House No. 24) providing that no person in any of the several Washington hospitals for the insane, or the State institution for the feebleminded, shall be discharged ~~unsterilized~~ if, in the judgment of the superintendent, procreation by such person "would produce children with an inherited tendency to crime, insanity, feeblemindedness, idiocy or imbecility, and there is no probability that the condition of such person will improve to such an extent as to render procreation by such person advisable." Friends or relatives of the patient may appeal from the decision of the superintendent to the Superior Court, who shall appoint three physicians to investigate. If a majority of this investigating committee overrules the superintendent's decision, the person shall be discharged from the institution. If they uphold the superintendent, "the court shall enter an order directing that such person shall not be discharged from such institution until such operation is performed." If the friends or relatives then consent to the operation, the patient shall be sterilized and discharged.

It is a temptation to State authorities, of course, to release as many of the State's wards as possible, in order to transfer the expense of their care from the State to private individuals. This is entirely proper if careful safeguards are established; but the present bill does not appear to us to provide any such safeguards. From a eugenic point of view, we think State segregation may give place to family segregation, where the relatives of an insane or feebleminded person are able to become responsible for him or her; but State segregation should not be replaced by sterilization and the reckless release of defective persons. The bulk of the persons affected will probably be the higher grades of feebleminded; these have the sexual impulses strongly developed, but their sexual inhibitions are weak or lacking: their freedom, sterilized, in the community, appears to us almost certain in a great many cases to make them foci for the dissemination of immorality and venereal diseases. That is a hygienic rather than a eugenic consideration, but it seems to us the most serious aspect of the sterilization idea. From the eugenic point of view, sterilization of the defective females ~~would be most important~~, and ~~it must~~ not be forgotten that sterilization of females is a serious matter, leading to expense, illness, and frequently danger. It is not to be undertaken on a wholesale scale without careful consideration.

OBJECTION TO THE BILL

Our objection, then, to this bill is that it is not adequate to serve the purpose for which it is intended. It makes no provision for the proper segregation of defectives after they have been released from a State institu-

tion, apparently assuming that if they are sterilized the State has done its full duty. We consider this idea to be entirely erroneous. Defectives should not be released from State custody unless their relatives and friends are certain to care for them properly; and in such cases, sterilization will frequently—although doubtless not always—be unnecessary. We think this bill should be defeated. Washington's existing sterilization law is practically not in effect,[1] and if its legislators cannot improve on this attempt at amendment, the State had better get along without a sterilization law and keep its defective wards properly and permanently isolated.

MISSOURI LEGISLATION

Missouri makes its first attempt to enter the ranks of legislative eugenists, in House Bill No. 385, now pending, which, after declaring that "habitual criminals, moral degenerates and sexual perverts are menaces to public health, peace and safety," and defining those classes, requires all superintendents of State hospitals for insane and feebleminded and the superintendent of the State penitentiary to report quarterly to the State Board of Health the names, record, character and condition of any such persons in their care. The board of health shall investigate each case, and if the subject is found to be as described, he shall be sterilized. He or his friends or relatives may appeal to a circuit court; if the finding of the board of health is sustained, sterilization shall proceed.

This measure declares itself to be a police regulation rather than an attempt to improve the average value of heredity in the State. From a eugenic standpoint, it appears to the writers to be of little value, and its defeat is desirable. Eugenic and police or punitive measures should not be confused—if they are linked together the public will get an inaccurate idea of what eugenics means; nor is it desirable that eugenic sterilization be considered a form of punishment. Furthermore, the bill takes no account of whether the inmate of a hospital for the insane or feebleminded, or the State penitentiary, is going to remain there for life. If he is, sterilization is foolish—the sexes should be segregated. If he is not, more care should be made necessary in arranging for his future; he should not be dismissed in this offhand manner as a person of no further concern to the State. The framers of this measure give no evidence of understanding the purpose of sterilization from a eugenic point of view: they appear to look on it as a sort of patent medicine, a bottle of which will wholly cure one of these degenerates whom they have described as menaces to public health, peace and safety. The eugenist cannot share that view.

IOWA'S "EUGENIC LAW"

Iowa has taken the subject of "eugenic laws" very seriously, but without practical results to date. In 1911 it adopted a sweeping statute for sterilization, which was never actually put in effect,[2] in 1913 it repealed this and adopted a substitute law which is still theoretically in force but under which, so far as is known to us, no operation has ever been performed. It is optional as regards most classes of degenerates, compulsory in case of persons twice convicted of an ordinary felony or sexual offense, and compulsory after one conviction for "white slavery." The latter provision obviously lends itself well to the purposes of blackmailers who are already making such profitable use of the Mann White Slave Act. The Iowa statute has never commended itself to many people, and House Bill No. 365, now pending, proposes to repeal it, and substitute a new law omitting criminals as such from the act and making it apply only to insane, idiots, imbeciles and feebleminded, and the syphilitic, who are confined in State institutions. Sterilization is to be performed whenever the superintendent and a majority of his medical staff agree that it is for the best interests of any patient and society; vasectomy for men and salpingectomy for women

[1] Eugenics Record Office Bulletin 10B, p. 80.
[2] Ibid., p. 87.

Cold Spring Harbor, N. Y., February, 1914.

are stipulated, a majority of the board of control must approve, and relatives or guardian of the patient must give their written consent. Obviously, this is a tremendous modification of the present law, and one in the right direction, although the inclusion of syphilitics in the classes which may be sterilized seems to the writers absolutely indefensible. Syphilis being a curable disease, there is no more reason for sterilizing a person with syphilis than a person with typhoid fever. The new bill also contains a provision that any person performing a sterilization operation except as provided for in this law shall be fined not more than $1,000 or imprisoned not more than one year in the penitentiary, or both. Were it not for this clause and the inclusion of syphilitics, the writers would favor the repeal of Iowa's present law and the adoption of this proposed measure; under the circumstances, it is hoped that this new proposal, unless amended will be defeated, and the old one repealed or allowed to rest in abeyance until a measure framed on more sensible lines can be introduced.

All things considered, the measures now pending in these four States do not indicate that the general public has been very well educated as to the possibilities and requirements of legislation to promote eugenics. A careful reading of the report of the Committee[3] which has been at work on the subject since 1911, under the chairmanship of Bleecker Van Wagenen, would show the proponents of these measures that they are in many cases far from the track marked out by genetics. And genetists are very strongly of the opinion that this is a subject on which they have the right to be heard.

"EUGENIC MARRIAGE LAWS"

But if legislative tendencies toward sterilization at the present time are of little value to the science of eugenics, certainly still less can be said for the widespread attempt to control marriage by various legislative devices. Bills which are hailed by the press and public as being "eugenic marriage laws" are now pending in the legislatures of nine States. In nearly every case these are wholly measures of social hygiene rather than eugenics; they are usually intended to aid in the campaign against venereal disease. The writers are in complete sympathy with this campaign, but not with its masquerade as a eugenic affair. The prevention of venereal disease is a matter of hygiene which lies in the field of public health; it has nothing whatever to do with eugenics, as venereal diseases are not hereditary and eugenics is concerned with heredity, not personal hygiene. The science of eugenics has plenty of work on its hands, without invading the field of preventive medicine, and it has already suffered enough in popular estimation through its undesired connection with sex hygiene. It is the duty of every eugenist vigorously to repudiate such bills as those which follow, in so far as they are represented to be eugenic laws; no matter how heartily he may indorse some or all of them as hygienic laws.

How far removed they are from the legitimate field of eugenics will best be seen by a review of them. Vermont has led the way with a bill passed by both houses of the legislature and approved by the governor on March 22, 1915, which provides a heavy fine or jail sentence for any person who, knowing himself to be infected with gonorrhea or syphilis, either marries or has sexual intercourse. Any physician treating a patient infected with a venereal disease must report the name, address, age and sex of such patient to the State Board of Health; he is paid $0.25 if he does and is fined $200 if he does not. The State Board of Health is empowered to make and enforce such rules and regulations for quarantining and treatment of venereal diseases as are deemed necessary. With the merits of this new law, the writers are not here concerned; they wish

[3] Report of the Committee to Study and to Report on the Best Practical Means of Cutting Off the Defective Germ-Plasm in the American Population. Eugenics Record Office, Cold Spring Harbor, New York, February, 1914. Bulletin 10A, The Scope of the Committee's Work; Bulletin 10B, The Legal, Legislative and Administrative Aspects of Sterilization; both by Harry H. Laughlin, secretary of the committee.

merely to point out that *it is not a eugenic law.*

House Bill No. 259, now pending before the Vermont legislature, has more claim to the attention of eugenists, as it is intended to bar marriage to the imbecile, insane and epileptic, as well as to any person who is or has been within five years an inmate of asylum or poorhouse, unless it is shown that the cause of such condition has been removed and that the prospective groom is able to support a family. License is also to be refused if either applicant is afflicted with a transmissible disease; freedom from such disease to be certified by a practicing physician. In view of the adoption of the law mentioned in the previous paragraph, it is not likely that this one will get on the statute books.

SOUTH DAKOTA'S BILL

At the request of the Social Science Club of Aberdeen, S. D., the Legislature of South Dakota is now considering a bill (House No. 131) which would require every applicant for a marriage license to present a certificate of fitness signed by the superintendent of the County Board of Health, showing that no communicable disease or mental or physical defect exists against contracting the marriage relation. In order that he may certify to this fitness, the superintendent of the County Board of Health shall make a personal examination of each applicant, at a cost of $5 to the applicant; if he decides that a laboratory test is necessary, he shall so order and $10 more shall be collected from the applicant. No certificate of fitness to marry shall be issued to an insane, feebleminded, epileptic or syphilitic person unless he or she has previously been sterilized. Transmissible contagious disease is an absolute bar to marriage.

In regard to this and other bills of the same type, little comment need here be made. They are badly designed and should not be passed, as eugenic measures.

The legislature of the state of New York is now considering a bill (House No. 513) amending the present law regarding marriages in such a way as to prohibit the issuance of a marriage license unless the applicant presents a certificate from a physician "that such applicant is free from any physical or mental infirmity or disease which is likely to be contagious, communicable or hereditary." A consideration of the experience of Wisconsin and its notorious "eugenic law" ought to cool the ardor of the backers of this measure.

Indiana is similarly considering a measure (Senate Bill No. 16) requiring applicants for a marriage license to present a certificate from a reputable physician showing that they are not feebleminded, insane, or afflicted with an open case of tuberculosis or any transmissible disease. The introduction of this bill may at least have some educative value on public opinion, by calling attention to the fact that tuberculosis is an extremely undesirable thing in a prospective life partner.

A so-called Eugenics bill has also been introduced into the Senate of Illinois. It requires that health certificates, signed by physicians, shall be presented by the prospective bride and groom prior to the issuance of a marriage license, and that no county clerk shall issue a marriage license to any person suffering from a communicable disease. This is a public health law, not a eugenics law.

Missouri proposes to go back to the old system of banns, in House Bill No. 17, which requires each applicant for a marriage license to present a certificate from a reputable physician which shall state in concise terms the applicant's health and his fitness to marry. Notice of application for marriage license shall be published in a daily paper three consecutive times, at the expense of the county. If at the expiration of one day from the publication of the last notice, no charges have been filed with the recorder alleging applicant's unfitness to marry, license shall be granted. If objection be made by three persons not related in blood to each other, on the ground of any item mentioned in the physician's certificate, the case shall be taken before the circuit court; if the court sustains the objection of these three unrelated persons, a license to wed shall be denied; if the court overrules

the objection the license shall be granted and the objectors will have for their pains the feeling that they tried to do their duty—and also a bill for the court costs.

PUBLICATION OF BANNS

In so far as this measure has any bearing on eugenics it is, in the present state of public opinion, premature. The idea of publishing the banns has appealed to many eugenists as desirable in preventing hasty and ill-considered marriages. There is much to be said for it, but such a bill as this is not likely to commend itself to any genetist, as the proper method of procedure, because three unrelated laymen and the judge of a circuit court are not the proper persons to decide on the biological fitness of a proposed marriage. It should and probably will be defeated.

Oregon already has a law requiring the male applicant for a marriage license to present a health certificate. Two bills on this subject are now before the House; No. 273 would amend the law to make the woman present a similar certificate, while No. 161 would repeal the existing law altogether. The law has probably already done what little service to eugenics it can render, by calling public attention to the desirability of health in a marriage mate. At present, public opinion is the only thing that can operate effectively, and it will be no loss to eugenics if the existing Oregon law, which is *not* a eugenic law, is repealed.

Nebraska is considering the addition of medical duties to the other functions of the judiciary. House Bill No. 571, now pending, provides that no marriage license may be issued to a person infected with a venereal disease. To enable the county judge to decide this point, he may require both applicants to come before him so that he may question them, either under oath or not; he may also require them to give affidavits. He shall also require the *male* applicant to present the affidavit of a physician of good standing to the effect that said physician has made a careful and thorough examination of said male applicant and finds him free from all symptoms of infectious venereal disease. The physician shall be paid a fee of $5 by the applicant unless he thinks a laboratory test needed, when he shall insist on such a test being made and shall be entitled to a fee of $25 from the applicant.

Although often hailed as a "eugenic marriage law," this bill of course has nothing to do with eugenics. Since the point is frequently raised, however, it may be worth while to suggest that no test except a laboratory test is of any real value in determining whether or not a man or woman is infected with a venereal disease; and that $25 is a rather high fee for the Wasserman test with Noguchi control, or any other test which is to be a legal prerequisite to marriage and which is to have such a widespread application. The Nebraska bill is not well drawn and should die.

WISCONSIN'S EXPERIENCE

Wisconsin, which stepped to the front of the procession in 1913 by adopting a law, miscalled eugenic, requiring every applicant for a marriage license to present a health certificate, has been having trouble with the enforcement of that law ever since, and House Bill No. 197, introduced at the present session of the legislature, would repeal it. House Bill No. 100, also pending, would abolish the physician's certificate and merely require each applicant to state on honor that he or she is free from "any acquired venereal disease." The framer of this measure will immortalize himself among students of heredity if he can show us any venereal disease that is not acquired.

Such, in outline, are the so-called "eugenic laws" of the present season, known to us, that are being considered or have been considered by State Legislatures. Not one of them commends itself to us. Most of them have nothing to do with eugenics; those that have some connection with eugenics are so inadequate or so carelessly drawn that their passage is undesirable. Their presentation has a certain value, in arousing public sentiment to the need of restricting the production of defectives in this country; but their appear-

ance in the present form indicates that public sentiment still has a wrong idea of the proper and profitable relation that can and should exist between legislation and eugenics. In general the writers believe, and most genetists have come to the same view, that sterilization by law is not in many cases a desirable procedure for eugenists to advocate; that permanent isolation of the defective classes is a preferable means of dealing with them; and that neither the science of eugenics nor public sentiment is ready for legislation putting restrictions on marriage, so far as those restrictions are strictly eugenic rather than hygienic in intent.

The kind of legislation that will really advance the science of eugenics at the present time is legislation that provides for research. The public seems to have an idea that the study of heredity is being profoundly cultivated by many well-equipped institutions and a large body of workers. As a fact, the active workers in this field are, and always have been, merely a corporal's guard. Their achievement is far out of proportion to their fewness; yet they have done little more than scratch the surface of the field. We have learned much; we have enough knowledge to make definite action profitable in many lines; but the distance we have yet to go is far greater than that we have already traversed. Immediate action in negative eugenics is in many quarters desirable, but the great need of eugenics, and one that is not being adequately met, is the need for more facts.

It is time for the friends of eugenics to stop promoting such legislation as that herein outlined, and to divert more of their energy to a broad, constructive policy for the furtherance of eugenics. They may, for example, very profitably help to:

Promote research in heredity;

Disseminate a knowledge of the laws of heredity;

Create a "eugenic conscience" in the public;

Give the young people of their acquaintance a chance to meet and fall in love with suitable life-partners;

Further every means that will remove some of the social and economic bars to marriage and parenthood, that now tell so heavily on our eugenically superior classes.

Heredity In Apples

Apple breeding was begun at the New York state experiment station (Geneva, N. Y.) in 1898, and 148 seedlings of crosses then made have fruited. The results of these crosses have satisfied the experimenters: (i) that seedling apples have very little tendency to revert to the wild prototype, despite the popular belief to the contrary; (ii) that some of the characters of apples seem to be prepotent in transmission. The vigor expected of a first hybrid generation is found to a marked degree.

Interesting facts regarding the inheritance of separate traits have been worked out. In color of skin, the fruits in which yellow predominates over red seem to be heterozygous; the fruits in which red predominates seem to be either homozygous or heterozygous, while those of pure yellow color are apparently homozygous. As to color of flesh in Ben Davis and McIntosh, whose crosses were most carefully studied, there is reason to believe that they carry both yellow and white, the latter being recessive. Sourness and sweetness may be allelomorphs, the former a dominant and the latter a recessive, since in many crosses there were three sour apples for every sweet one. In general, the experimenters do not think Mendelism offers much practical promise in improving varieties of apples. They further think that size and shape are inherited in an intermediate or blended condition: which is perhaps the same as saying that they are caused by so many separate characters, inherited independently, that the crosses produce almost every possible result.

NATURE OR NURTURE?

Actual Improvement of the Race Impossible Except through Heredity—Facts on Which the Eugenist Bases His Faith—The Attitude of Eugenics Toward Social Problems[1]

The Editor

LITTLE more than a year ago I sat on the same platform with the late Jacob Riis, at a conference on race betterment. A number of members of our association spoke of the need for improving the heredity of the children of the slums. Finally Jacob Riis took the floor.

"We have heard friends here talk about heredity," he exclaimed. "The word has rung in my ears until I am sick of it. Heredity, heredity! There is just one heredity in all the world that is ours—we are children of God, and there is nothing in the whole big world that we cannot do in his service with it."

That, I regret to say, is the attitude still held by a great many social workers—the people who would see the power of heredity demonstrated before their own eyes every day, if their eyes were not closed by preconceived ideas. I am not going to waste any time demonstrating to you that there is such a thing as heredity, because I believe you would all be willing to admit it—as an academic question, as a theory. But I dare say that when it comes to practice, a great many of you tacitly proceed on the assumption that Jacob Riis stated so explicitly and vigorously. You want to see the world made better, and you therefore support charities, legislation, uplift movements, philanthropic attempts at social betterment, all of which have as their object the improvement of the environment of persons who are living in a bad environment. You believe that by so doing you ensure the improvement of the race.

Now if you are right in acting on this principle, then we eugenists are largely wrong. If you can better the race by improving its environment, then you have found a short cut in social progress, which we are too blind or stupid to follow. If all that every man needs is a chance, then we are hunting on the wrong scent.

The faith of the social worker, the legislator, the physician, the sanitarian, in his method of improving the race is very literally the kind of faith that St. Paul described as the substance of things hoped for, the evidence of things not seen. We eugenists have a stronger faith, because it is based on things that are seen, and that can even be measured. We think we can prove that it is, on the whole, man who makes the environment, not the environment which makes man. We are far from denying that nurture has an influence on nature, to use Galton's antithesis, but we believe that the influence of nurture, the environment, is only a fifth or perhaps a tenth that of nature—heredity.

If we can prove this to you, I think eugenics will have justified its claim to consideration. If we cannot you may properly scorn us for wasting your time and ours. I shall therefore give up this evening to an endeavor to prove to you that man is largely the product of his heredity, and that environment has no power to improve this heredity and not much, within ordinary limits, to deteriorate it. If I succeed in convincing you, I shall expect you to join us in believing that the way to improve the race is not to work on a lot of bad heredity, but to see that a larger supply of good heredity is made available.

WHAT BIOLOGY TEACHES

The problem, like many others in eugenics, might be attacked from two

[1] A lecture to the Young Men's Christian Association, Washington, D. C., March 18, 1915.

sides—the biological and the statistical. An understanding of the facts of biology leads us to expect that heredity should be nearly all-powerful and the force of environment slight. Experiments confirm this expectation. The University of Missouri, for example, is now carrying on a long breeding experiment to determine whether the milking capacity of cows is due to heredity, or whether it is largely dependent on the good care and feed they receive. Cows are being subjected to all sorts of treatment at all ages, and the experiment has shown beyond question that the milk-yield is a matter of heredity, and is very little influenced by differences in the treatment of cows at any age. In plants and low animal organisms the influence of the environment is considerable, but it diminishes as we rise higher in the evolutionary scale. The student of modern biology can hardly conceive of the possibility that heredity in man should not be more important than environment.

But that would not be a convincing way of presenting the problem to this audience, and I shall therefore present it largely from the statistical side. When we deal with things that we can measure and express in numbers, we have facts whose value you can decide for yourselves. I shall not try to present a solution of the problem in general terms, for I do not think it can be done, but I shall pick out a number of definite examples and try to show you the relative weight of heredity and environment in them.

At the Race Betterment Conference, of which I spoke at the beginning of this paper, Byron W. Holt, a prominent New York social worker, declared, "It will hardly be denied that the two most important and fundamental causes of preventable disease, as well as of crime and race deterioration, are (1) ignorance and (2) poverty." It certainly will be denied; I venture to say that it will be denied, and vehemently denied, by anyone who knows anything about the facts. Such a confusion of cause and effect is the most widespread and serious hindrance to the spread of eugenic ideas. Because a good environment makes it possible for hereditary traits to get expression, people jump to the conclusion that the environment created these traits. The improvement of the environment, absolutely essential as it is, must never be neglected for a minute; but our mistake has been in looking on it as an end rather than as a means. It is not an end; it is merely a means of giving good heredity a chance for expression. If the good heredity is not there, it is hardly worth while to improve the environment: certainly it is a waste of time if it is done with the idea of thereby improving a stream of bad heredity in it.

SOME FAMILIAR EXAMPLES

The limited effect of nurture in changing nature is in some fields a matter of common observation, if you only stop to think of it in that light. You men who work in the gymnasium know that exercise increases the strength of a given group of muscles, but that this does not go on increasing indefinitely. There comes a time when the limit of your hereditary potentiality is reached, and no amount of exercise will gain another millimeter in the circumference of your arm. Similarly the handball or tennis player some day reaches his highest point, and even if he redoubles his amount of practice and study of the game after that, he is unable to increase the precision of his shots or the speed of his play. The same thing applies to runners or race horses—one can do no more than give their inborn ability a chance to express itself. A trainer could bring Arthur Duffy in a few years to the point of running a hundred yards in $9^3/_5$ seconds, but no amount of training after that could clip off another fifth of a second; while if the same trainer had had me, even from childhood, it is doubtful whether he would ever have gotten me to run it in 10 seconds. A parallel case is found in the students who take a college examination. Half a dozen of them may have devoted the same amount of time to it—may have crammed to the limit—but they will still receive widely different marks. These commonplace cases show that nurture has seemingly

some power to mould the individual, by giving his inborn possibilities a chance to express themselves, but that nature says the first and last word. Francis Galton, the father of eugenics, hit on an ingenious and more convincing illustration, by studying the history of twins.

There are, as you know, two kinds of twins—ordinary twins and the so-called identical twins. Ordinary twins are merely brothers, or sisters, or brother and sister, who happen to be born two at a time, because two ova have developed simultaneously. The fact that they were born at the same time does not make them alike—they differ quite as widely from each other as ordinary brothers and sisters do. Identical twins have their origin in a different phenomenon—they are halves of the same egg, which split in two at a very early stage of its development, each of the halves then developing into a separate individual. As would be expected, these identical twins are always of the same sex, and extremely like each other, so that sometimes their own mother can not tell them apart. This likeness extends to all sorts of traits—they may lose their milk teeth on the same day, they may become sick on the same day with the same disease, even though they be in different cities, and so on.

Now Galton reasoned that if environment really changes the inborn character, then these identical twins, who start life as halves of the same whole, ought to become more unlike if they were brought up apart; and as they grew older and moved into different spheres of activity, they ought to become measurably dissimilar. In the case of ordinary twins, who start dissimilar, they ought to become more alike when brought up in the same family, on the same diet, among the same friends, with the same education. If the course of years shows that identical twins remain as like as ever and ordinary twins as unlike as ever, regardless of changes in conditions, then environment will have failed to demonstrate that it has any great power to modify one's inborn nature.

With this view, Galton collected the history of eighty pairs of identical twins, thirty-five of which cases were accompanied by very full details, which showed satisfactorily that the twins were really as nearly identical, in childhood, as one could expect to find. I can not quote his long and interesting descriptions of them; I can only state the conclusion. In the case of these thirty-five pairs who were "closely alike" in both body and mind, during childhood and youth, when they were brought up in the same environment, what changes did their separation into different environments, different walks of life, when they grew up, produce? In many cases the resemblance of body and mind continued unaltered up to old age, notwithstanding very different conditions of life; in others a severe disease was sufficient to account for some change noticed. Other dissimilarity that developed, Galton had reason to believe, was due to the development of inborn characters that appeared late in life. He therefore felt justified in broadly concluding "that the only circumstance, within the range of those by which persons of similar conditions of life are affected, that is capable of producing a marked effect on the character of adults, is illness or some accident which causes physical infirmity. The twins who closely resembled each other in childhood and early youth, and were reared under not very dissimilar conditions, either grow unlike through the development of natural (that is, inherited) characteristics which had lain dormant at first, or else they continue their lives, keeping time like two watches, hardly to be thrown out of accord except by some physical jar."

Now let us consider the ordinary twins, who were unlike from the start, and see how far nurture has made them resemble each other. I cannot take time to cite Galton's evidence, which was presented in his usual cautious way. It led him to write: "The impression that all this evidence makes on the mind is one of some wonder whether nurture can do anything at all, beyond giving instruction and profestional training." The unlike twins never became any more like, no matter

under how similar conditions they existed; so that to Galton there seemed "no escape from the conclusion that nature prevails enormously over nurture, when the differences of nurture do not exceed what is commonly to be found among persons of the same rank in society and in the same country."

This kind of evidence was a good start for eugenics, but as the science grew, we outgrew such evidence. We no longer wanted to be told, no matter how minute the details, that "nature prevails enormously over nurture." We wanted to know exactly how much. We refused to be satisfied with the statement that a certain quantity was large; we demanded that it be measured or weighed. So Galton, Karl Pearson and other mathematicians devised means of doing this, and then Professor Edward L. Thorndike of Columbia University took up Galton's problem again, with the new methods, from whose conclusions we think there can be no appeal.

THE COEFFICIENT OF CORRELATION

The tool used by Professor Thorndike was the coefficient of correlation, which shows the amount of resemblance or association between any two things that are capable of measurement, and is expressed in the form of a decimal fraction somewhere between 0 and the unit 1. Zero shows that there is no constant resemblance at all between the two things concerned, that they are wholly independent of each other, while 1 shows that they are completely dependent on each other—a condition that rarely exists, of course.[2] For instance, the correlation between the right and left femur in man's legs is .98. The nearer our fraction approaches unity, the greater is the resemblance and the smaller it is, the less is the resemblance; while a coefficient of .9 is, of course, three times as great as a coefficient of .3; and so on.

Thorndike picked out in the New York schools fifty pairs of twins about the same age and measured the closeness of their resemblance in eight physical characters, and also in six mental characters, the latter being measured by the proficiency with which the subjects performed various tests. Then children of the same age and sex, picked at random from the same schools, were measured in the same way. It was thus possible to tell how much more alike twins were than ordinary children in the same environment.

"If now these resemblances are due to the fact that the two members of any twin pair are treated alike at home, have the same parental models, attend the same school and are subject in general to closely similar environmental conditions, then (1) twins should, up to the age of leaving home, grow more and more alike, and in our measurements the twins 13 and 14 years old should be much more alike than those 9 and 10 years old. Again (2) if similarity in training is the cause of similarity in mental traits, ordinary fraternal pairs not over four or five years apart in age should show a resemblance somewhat nearly as great as twin pairs, for the home and school condition of a pair of the former will not be much less similar than those of a pair of the latter. Again, (3) if training is the cause, twins should show greater resemblance in the case of traits much subject to training, such as ability in addition or in multiplication, than in traits less subject to training, such as quickness in marking off the A's on a sheet of printed capitals, or in writing the opposites of words."

THORNDIKE'S CONCLUSIONS

The data were elaborately analyzed from many points of view. They showed (1) that the twins 12-14 years old were not any more alike than the twins 9-11 years old, although they ought to have been, if environment had any power to mould the character during these so-called "plastic years of childhood." They showed (2) that the resemblance between twins was two or

[2] What I say here refers to positive correlations, which are the only kind I cite in this paper. Correlations may also be negative, lying between 0 and —1: for instance, if we measured the correlation between a man's lack of appetite and the time that had elapsed since his last meal, we should have to express it by a negative fraction, the minus sign showing that the greater his satiety, the less would be the time since his repast.

three times as great as between ordinary children of the same age and sex, brought up under similar environment. There seems to be no reason why twins should be more alike, unless it is due to the power of heredity. The data showed (3) that the twins were no more alike in traits subject to much training than in traits subject to little or no training. Their achievement in these traits was determined by their heredity; no amount of training could alter these hereditary potentialities.

"The facts," Thorndike wrote, "are easily, simply and completely explained by one simple hypothesis: namely, that the natures of the germ-cells—the conditions of conception—cause whatever similarities and differences exist in the original natures of men, that these conditions influence mind and body equally, and that in life the differences in modification of mind and body produced by such differences as obtain between the environments of present-day New York City public school children are slight." He reached the same conclusion that other studies of this sort have shown, that in the make-up of the individual there are probably nine parts of heredity for every one of nurture or training.

"The inferences," he says, "with respect to the enormous importance of original nature in determining the behavior and achievments of any man in comparison with his fellows of the same period of civilization and conditions of life are obvious. All theories of human life must accept as a first principle the fact that human beings at birth differ enormously in mental capacities and that these differences are largely due to similar differences in their ancestry. All attempts to change human nature must accept as their most important condition the limits set by original nature to each individual."

Meantime other investigators, principally followers of Karl Pearson in England, were working out correlation coefficients in other lines of research for hundreds of different traits. It was found, no matter what physical or mental trait was measured, that the coefficient of correlation between parent and child was a little less than .5 and that the coefficient between brother and brother, or sister and sister, or brother and sister, was little more than .5. On the average of many cases, the mean "nature" value, the coefficient of direct heredity, was placed at .51. This gave another means of measuring the relative importance of nature and nurture, for it was also possible to measure the relation between any trait in the child and some factor in the environment. A specific instance will make this clearer.

MYOPIA OF SCHOOL CHILDREN

We know that school children show an appalling amount of eye trouble, particularly short-sightedness. Now suppose it is suggested that this is because they are allowed to learn to read at too early an age. We can find out the age at which any given child did learn to read, and work out the coefficient of correlation between this age and the child's amount of myopia. If we find the relation is very close between them—say .7 or .8—we will know that the earlier a child learns to read, the more short-sighted he is as he grows older. This will not prove a relation of cause and effect, but it will at least give us great suspicion. If on the contrary we find the correlation very slight, we are forced to admit that early reading has nothing to do with the prevalence of defective vision among school children. If we similarly work out all the other correlations that can be suggested, finding whether there is any regular relation between myopia and overcrowding, long hours of study, general economic conditions at home, general physical or moral conditions of parents, the time the child spends out of doors, etc., and if we find there is no relation of any moment between these various factors and myopia, we are driven to admit that no factor of the environment which we can think of as likely to cause the trouble really has anything to do with the poor eyesight of our school children. This has actually been done, and none of the conditions I have enumerated has been found to be closely related to myopia

in school children. Correlations between fifteen environmental conditions and the goodness of children's eyesight were measured, and only in one case was the correlation as high as .1. The mean of these correlations was about .04—an absolutely negligible quantity when compared with the heredity coefficient of .51. Does this prove that the myopia is rather due to heredity? It would, by a process of exclusion, if we could be sure that we had measured every conceivable environmental factor and found it wanting. We can never reach that point in the investigation, but we have at least reached, it seems to me, a tremendously strong suspicion. Now if we go on and measure the degree of resemblance between the prevalence of myopia in parents and that in children, and if we find that when the parent has eye trouble, the child also has it, then it seems to me that our general knowledge of heredity should lead us to believe that we have put our finger on the difficulty, and that we were seeking an environmental cause for the poor vision of the school child, when it was all the time due almost entirely to heredity. This final step has not yet been completed in an adequate way,[3] but the evidence we have, partly analogical, gives every reason to believe in the soundness of the conclusion I stated, that in most cases the school-boy must wear glasses because of his heredity, not because of overstudy or any neglect on the part of his parents to care for his eyes properly during his childhood.

I have explained this case at some length, so you might understand clearly the way in which we have proceeded to pile up mathematical proof of the preponderating importance of heredity as compared with environment. I shall now run over several similar cases more hastily.

INTELLIGENCE OF SCHOOL CHILDREN

The extent to which the intelligence of school children is dependent on defective physique and unfavorable home environment is an important practical question, which David Heron of London attacked by the methods I have outlined. He wanted to find out whether the healthy children were the most intelligent. We are constantly hearing stories of how the intelligence of school children has been improved by some treatment which improved their general health, but these stories are rarely presented in such a way as to constitute evidence of scientific value. We wanted to know what exact measurement would show: whether it was really possible that the dullards became prodigies as soon as their adenoids were removed, whether hot lunches really increased the brain power, and so on. The intelligence of all the children in fourteen schools was measured in its correlation with weight and height, condition of clothing and teeth, state of nutrition, cleanliness, good hearing, and the condition of the cervical glands, tonsils and adenoids. It could not be found that mental capacity was closely related to any of the characters dealt with. The rather curious set of characters measured was taken because it happened to be furnished by data collected for another purpose; the various items are suggestive rather than directly conclusive. Here again, the correlation in most cases was less than .1, as compared with the heredity correlation of .5.

Next, take the very complex subject of tuberculosis. Certainly we would not say that it is inherited, but there is

[3] Dr. James Alexander Wilson, assistant surgeon of the Opthalmic Institute, Glasgow, published an analysis of 1,500 cases of myopia in the *British Medical Journal*, p. 395, August 29, 1914. His methods are not above criticism, and too much importance should not be attached to his results, which show that in 58% of the cases heredity can be credited with the myopia of the patient. In 12% of the cases it was due to inflammation of the cornea (keratitis) while in the remaining 30% no hereditary influence could be proved, but various reasons made him feel certain that in many cases it existed. The distribution of myopia by trades and professions among his patients is suggestive: 65% of the cases among school children showed myopic heredity, 63% among housewives and domestic servants, 68% among shop and factory workers, 60% among clerks and typists, 60% among laborers and miners. If environment really played an active part, one would not expect to find this similarity in percentages between laborers and clerks, between housewives and school children, etc.

good reason to believe that its appearance in any individual is largely due to his inheritance of what physicians call the tubercular diathesis—that is, a weakness of the constitution predisposing to tuberculosis. As compared with this factor, all factors of infection are of relatively small importance. Under modern city conditions, it is almost certain that one who leads a moderately active life will be exposed to infection from tuberculosis every day. Whether he succumbs or resists will depend on his heredity.

But, it is argued, at any rate bad housing and unsanitary conditions of life will make infection more easy and lower the resistance of the individual. Perhaps such conditions may make infection more easy, but that is of little importance considering how easy they are for each of us—for the population as a whole. The question remains, will not bad housing cause a greater liability to fatal phthisis? Will not destitution and its attendant conditions increase the probability that a given individual will succumb to the white plague?

CAUSES OF DEATH FROM PHTHISIS

Most physicians think this to be the case, but they have not taken the pains to find out, by the exact methods of modern science. We are accustomed to take their word on the subject, because we think they ought to know. Dr. Knopf of New York, one of the country's authorities on tuberculosis, recognizes the importance of the heredity factor, but says that after this, the most important predisposing conditions are of the nature of unsanitary schools, unsanitary tenements, unsanitary factories and workshops. This may be very true; these conditions may follow after heredity in importance—but how near do they follow? That is a matter that is capable of fairly accurate measurement, and we ought to have figures, not generalities.

Taking the case of destitution, which includes, necessarily, most of the other evils specified, Pearson measured the correlation with liability to phthisis and found it to be .02. The correlation for tuberculosis between parent and child, on the other hand, was found from several investigations to be about .50—just what we should expect, for that is the correlation in general for physical and mental characters in heredity. It is also the correlation for the inheritance of such pathological characters as insanity and congenital deafness, where certainly infection of child by parent could not be suspected.

Nevertheless, many thought that the high correlation between parent and child, in the case of tuberculosis, must be due to infection. The family relations are so intimate, they said, that it is folly to overlook this factor in the spread of the disease.

Very well, Pearson replied, if the relations between parent and child are so intimate that they lead to infection, they are certainly not less intimate between husband and wife, and there ought to be just as much infection in this relationship as in the former. The correlation was measured in thousands of cases and was found to lie around .25, being lowest in the poorer classes and highest in the well-to-do classes.

At first glance this looks like a damaging correlation—it looks as if there must be a considerable amount of tubercular infection between husband and wife. But when we find that the resemblance between husband and wife in the matter of insanity is also .25, we must pause. Certainly it will hardly be argued that one of the partners infects the other with this disability!

ASSORTATIVE MATING

As a fact, this correlation of say .25 between husband and wife, for tuberculosis, probably means very little for infection. What it does mean is that like tends to mate with like—in the more prosperous classes, at least, where there is a considerable range of choice. It means assortative marriage, sexual selection. This coefficient of resemblance between husband and wife in regard to phthisis is about the same as the correlation of resemblance between husband and wife for eye color, stature, longevity, general health, truthfulness, tone of voice, and many other charac-

ters. No one will suppose that life partners "infect" each other in these respects. Certainly no one will claim that a man deliberately selects a wife on the basis of a resemblance to himself in these points; but he most certainly does so unconsciously—a fact not discovered until the application of exact methods to the study of heredity revealed it and destroyed the old popular belief that unlike persons tend to marry each other. Assortative mating is now a well-established fact, and there is reason to believe that much, if not most, of the resemblance between husband and wife as regards tuberculosis is due to this fact, and not to infection. The comparison between heredity and environment which I made above is, therefore, a perfectly legitimate one—that is, .02 between environment and phthisis in the child, .50 between a tuberculous parent and the same disease in the child.

We would not dogmatically assert that right environment is of no importance in the case of tuberculosis; but our knowledge justifies us in asserting that no feature of the environment is as important as the heredity; and that the effective way to stamp out the White Plague is not to be found in the multiplication of sanatoria and restrictive regulations, or even in the better sanitation of our slums, desirable as these things may be in themselves; but that tuberculosis will be most surely and quickly eradicated when marriages between persons who come from tuberculous stocks are prevented.

EMPLOYMENT OF MOTHERS

Now take the question of employment for mothers. There has been a deal of agitation on the subject in recent years, and a certain amount of legislation has been passed, particularly in France, to relieve mothers of work outside their own homes. This is a desirable object in many ways, but if it is claimed, as it usually is claimed, that employment of mothers is detrimental to their children, and that mothers who stay at home and give all their time to their children will bring up healthier and more intelligent children, the assumption is involved that the character of the child is due to his environment as well as to his heredity; and the eugenist properly may demand the right to be heard. It is possible to measure with fair accuracy the correlation between employment of mother and various characters such as weight, height, health and intelligence of her children. This has been done with some carefully compiled Scotch statistics, and it has been found that the correlations are almost insignificant, averaging .11. To put the conclusion in less mathematical language, the fact that a mother may be employed outside her own home is found not to have any noteworthy unfavorable result on such characters of the children as were measured—namely, height, weight, general health and general intelligence. On the basis of these figures, the eugenist demands that the movement for changes in our present social arrangements, such as will permit mothers to stay at home and give all their time to their children, appear in the proper light, and that it do not claim to be able to improve the character of the children, when that character is really determined at birth and can be little influenced afterward by any except extraordinary environmental conditions.

These problems of bad breeding are pressing problems, but I have discussed them long enough. After all, eugenics, as its name indicates, is more interested in good breeding than in bad breeding. Let us see how heredity and environment are related in the production of great mental and moral superiority. If we can learn that, we ought to be in the way of producing more such superiority in the world—a thing as to the desirability of which there need be no argument.

If success in life—the kind of success that is due to great mental and moral superiority—is due to the opportunities a man has, then it ought to be pretty evenly distributed among all the persons who have had favorable opportunities, provided we take a big enough number of persons to allow the laws of probability full play. England offers a good field to investigate this point, because Oxford

and Cambridge, her two great universities, turn out practically all the eminent men of the country, or at least have done so until recently. If nothing more is necessary to ensure a youth's success than to give him a first-class education and the chance to associate with superior people, then the prizes of life ought to be pretty evenly distributed among the graduates of the two universities, during a period of a century or two.

SUCCESS A FAMILY AFFAIR

This is not the case. When we look at the history of England, as Galton did nearly half a century ago, we find success in life is pretty strictly a family affair. The distinguished father is likely to have a distinguished son, while the son of a nobody has a very small chance of becoming distinguished. To cite one concrete case, Galton found that the son of a distinguished judge had about one chance in four of becoming himself distinguished, while the son of a man picked out at random from the population had about one chance in 4,000 of becoming similarly distinguished.

The objection at once occurs that perhaps social opportunities yet play the predominant part; that the son of an obscure man never gets a chance, while the son of the prominent man is pushed forward regardless of his inherent abilities. This, as Galton showed at length, can not be held to be true of men of really eminent attainments. The true genius rises despite all obstacles, while no amount of family pull will succeed in making a mediocrity into a genius, although it may land him in some high and very comfortable official position. Galton found a good illustration in the papacy, where during many centuries it was the custom for a pope to adopt one of his nephews as a son, and push him forward in every way. If opportunity were all that is required, these adopted sons ought to have reached eminence as often as a real son would have done; but statistics show that they reached eminence only as often as would be expected for nephews of great men, whose chance is notably less, of course, than that of sons of great men, in whom the force of heredity is much stronger.

But we can come closer home and present a telling argument, I believe, from this, our own land of equal opportunities, where it is a popular superstition that every boy has a chance to be president, and where the youth reared in the log cabin and educated in the little red school-house is the dark horse we usually pick as a winner. The picturesque environment of some of our great men has so interested us that we have almost come to believe it is this environment—the log cabin and country school-house, for example—that have made these men great. A more careful scrutiny of the facts may convince us that such environment was nothing more than an incident, sometimes beneficial, sometimes prejudicial. It was their sterling heredity which carried these boys to the top. Let us look at the records of the eminent men this country has produced, in order to see whether in free America the prizes of life are in the grasp of all. Success may be a family affair in caste-ridden England; is it possible that such could be the case in our own continent of boundless opportunities?

Galton found that about half of the great men of England had distinguished close relatives. Now if our great men of America have fewer distinguished close relatives, environment will be able to make out a plausible case, and we will have to accredit some of the success of England's great men to family pull, rather than family heredity.

AMERICA'S GREAT MEN

Dr. F. A. Woods, chairman of the eugenics research committee of the American Genetic Association, has worked out this problem, and his results are a very satisfactory vindication of our claims.

First, let us find how many eminent men there are in our history. Biographical dictionaries list about 3,500 and it will be convenient to take this number, since it provides an unbiased standard from which to work. Now, Woods says, if we suppose the average

person to have as many as twenty close relatives—as near as an uncle or a grandson—then computation shows that only one person in 500 in the United States has a chance to be a near relative of one of our 3,500 eminent men—provided it is purely a matter of chance. As a fact, the 3,500 eminent men listed by the biographical dictionaries are related to each other not as one in 500, but as one in five. If the more celebrated men alone be considered, it is found that the percentage increases so that about one in three of them has a close relative who is also distinguished. "This ratio increases to more than one in two when the families of the forty-six Americans in the Hall of Fame are made the basis of study. If all the eminent relations of those in the Hall of Fame are counted, they average more than one apiece. Therefore, they are from five hundred to a thousand times as much related to distinguished people as the ordinary mortal is."

To look at it from another viewpoint, something like 1% of the population of the country is as likely to produce a man of genius as is all the rest of the population put together—the other 99%. And this is due not to environment, but to biological heredity. Let me prove this to you by running rapidly over Dr. Woods' careful studies of the royal families of Europe. Here certainly we may say that—on the whole, at least—environment has always been favorable. It has varied, naturally, in each case, but speaking broadly it is certain that all the members of this group have had the advantage of a good education, of all the care and attention that could possibly be given. If environment affects achievement, then we ought to expect the achievements of this class to be pretty generally distributed among the whole class. If opportunity is the cause of a man's success, then we ought to expect most of the members of this class to have succeeded, because to every one of the royal blood the door of opportunity usually stands open. We would expect the heir to the throne to show a better record than his younger brothers, however, because his opportunity to distinguish himself is naturally greater. I shall discuss this last point first.

EMINENCE IN ROYALTY

Dr. Woods divided all the individuals in his study into ten classes for intellectuality and ten for morality, those most deficient in these qualities being put in class 1, while the men and women of preeminent intellectual and moral worth were put in class 10. Now if preeminent intellect and morality were at all linked with the better chances that an inheritor of succession has, then we ought to find heirs to the throne more plentiful in the higher grades than in the lower. Actual count shows this not to be the case. A slightly larger percentage of inheritors is rather to be found in the lower grades. The younger sons have made just as good a showing as the ones who succeeded to power: as we should expect if intellect and morality are due largely to heredity, but as we should not expect if intellect and morality are due largely to outward circumstances.

Are "conditions of turmoil, stress and adversity" strong forces in the production of great men, as has often been claimed? There is no evidence from facts to support that view. In the case of a few great commanders, the times have seemed particularly favorable. Napoleon, for example, could hardly have been Napoleon had it not been for the French revolution. But in general there have been wars going on during the whole period of modern European history; there have always been opportunities for a royal hero to make his appearance; but often the country has called for many years in vain. Circumstances were powerless to produce a great man and the nation had to wait until heredity produced him. Spain has for several centuries been calling for genius in leadership; but in vain. England could not get an able man from the Stuart line, despite her need, and had to wait for William of Orange, who was a descendant of a man of genius, William the Silent. "Italy had to wait fifty years in bondage for her deliverers, Cavour, Garibaldi and Victor Emmanuel."

"The upshot of it all," Woods decides, "is that, as regards intellectual life, environment is a totally inadequate explanation. If it explains certain characters in certain instances, it always fails to explain many more; while heredity not only explains all (or at least 90 % of the intellectual side of character in practically every instance, but does so best when questions of environment are left out of discussion."

GENIUSES CLOSELY RELATED

Despite the good environment almost uniformly present, the geniuses in royalty are not scattered over the surface of the pedigree chart, but form isolated little groups of closely related individuals. One centers in Frederick the Great, another in Queen Isabella of Spain, a third in William the Silent, and a fourth in Gustavus Adolphus. Furthermore, the royal personages who are conspicuously low in intellect and morality are similarly grouped. Careful study of the circumstances shows nothing in the environment that would produce this grouping of genius, while it is exactly what our knowledge of heredity leads us to expect.

In the next place, do the superior members of royalty have proportionately more superior individuals among their close relatives, as we found to be the case among the Americans in the Hall of Fame? A count shows at once that they do. The first six grades all have about an equal number of eminent relatives, but grade 7 has more, while grade 8 has more than grade 7, grade 9 has more than grade 8, and the geniuses of grade 10 have the highest proportion of near relatives of their own character. Surely it cannot be supposed that a relative of a king in grade 8 has on the average a much less favorable environment than a relative of a king in grade 10. Is it not fair, then, to assume that this relative's greater endowment in the latter case is due to heredity?

Conditions are the same, whether males or females be considered.

Woods next strengthens his case by mathematics, working out coefficients of correlation for the characters of his subjects. I shall not trouble you with these, but shall merely tell you that on the whole they correspond with surprising closeness to the figures which theory would lead us to expect.

Thus, the reasons for the belief that heredity is almost the entire cause for the mental differences of these men and women, and that environment or free-will must consequently play very minor roles, are that the measurements we make of actual cases coincide almost exactly with what the laws of heredity lead us to expect; and secondly, the fact that environment or opportunity can hardly be expected to cause, in royalty at least, the great names to occur in close blood connection with others of the same stamp, as we find that they do occur.

It will be interesting to see just what Woods thinks the proportion of real genius in royalty is. His study includes 823 individuals about whom he was able to get sufficiently detailed data to work on, and in this number about twenty are to be classed as geniuses—men who would have made their mark as geniuses by their worth alone, starting from any walk of life, and quite apart from the favorable opportunities which their royal blood furnished them. This score of geniuses includes Louis II of Bourbon, "The Great Condé;" William the Silent, of Orange; John the Great of Portugal; Frederick William, the Great Elector of Prussia; Frederick the Great; Gustavus Vasa and Gustavus Adolphus of Sweden; and in the grade below this, such men as Admiral Coligny, William III of England, Peter the Great, Prince Eugene of Savoy; Maurice, the Elector of Saxony; Charles XII of Sweden; the Great Turenne, and so on. Now if we accept the count of twenty real geniuses in this group of 823 members of royalty, we have one genius in forty appearing in this stock. How does this compare with the rest of the population?

A SELECTED BREED

In the whole period in question, covering a number of centuries, Woods thinks there have certainly not been more than 200 men of equal eminence produced by the entire population of the countries

concerned. Yet this population included some hundreds of millions of persons. Royalty, then, has several hundred thousand times as many chances of producing a genius, as has a family picked at random from the population at large. And this overwhelming chance is due, as I have attempted to show, not to the fact that royalty has an unusually good environment or more opportunities, but to the fact that the royal families are a selected breed, who owe their origin to some one's preeminence in statecraft, war and leadership, and who have been more or less consciously bred for these qualities ever since. It is a gigantic, if incomplete, experiment in eugenics. Of course, we might have preferred to see other qualities picked out as the basis for such an experiment; but whatever qualities we selected, whether in the scientific, artistic, or practical sphere, we have every reason to believe that we could have produced a breed of men where genius would be relatively as abundant as it is in this stock.

I have now shown you specimens of many kinds of the evidence on which we rely to prove our contention that man's qualities, physical, mental or moral, are far more due to heredity than to his environment. I will not multiply statistics: what I have set before you is a fair example of our ammunition. The conclusions to which this kind of inquiry leads are startling to most people, and we wish to use all due caution in stating them.

Let it be understood, then, that the problem of heredity vs. environment is an extremely complex one and cannot be solved in general terms. We can only attack each phase of it separately, disentangle factors that can be measured, and compare them with each other. I believe no one has ever questioned the propriety of this method of attack. In every case that has ever been tried, so far as I know, the influence of heredity has been shown to be overwhelmingly predominant, and the power of any ordinary change in environment to modify heredity has been shown to be insignificant. We therefore feel ourselves in a position safely to generalize to the extent of saying that the importance of nature is five or ten times greater than that of nurture in the making of a man.

Probably the objection will at once occur to some of you, that my entire line of reasoning is unfair, because I have been measuring the total force of heredity against some single factor of environment in each case. You may be willing to grant that the power of heredity is greater than that of any single factor of environment, but you may think that if I took all the factors of environment put together—provided such a thing were possible—and measured them against heredity, the sum of them would vastly outweigh heredity.

SUPERIORITY OF HEREDITY

This is not the case, but the proof demands too much mathematics to be given. I will do no more than tell you that it involves a principle known as multiple correlation, and the fact that the various factors of the environment are rather closely correlated to each other. The result of this is that even if we had an infinity of environmental factors, each separate one correlated to the individual to an equal degree with that individual's parents or grandparents, yet the effect of these parents and grandparents alone would be greater than that of this infinity of environmental factors of the same grade of correlation; to say nothing of the influence of more remote ancestors, who are by no means to be neglected. Such a statement may seem incredible to you; but if you are not mathematically inclined enough to investigate the subject for yourself, I will have to ask you to take the word of mathematicians for it, that such is incontrovertibly the fact. No one can successfully dispute, I think, that *heredity is not only much stronger that any single factor of the environment, in producing important human differences, but is stronger than any possible number of them put together.* It is on this fact that we base our claim for a consideration of heredity in the solution of social problems, which are now attacked mainly through the environment alone.

A rapidly growing and influential school of sociologists has already grasped

the situation, and is basing itself solidly on biology, on the facts that I have set before you this evening. But there are yet a great many social workers, particularly those who have been trained largely along psychological lines, who still show an extraordinary inability to reason accurately. An example of this school's attitude may be found in a recent article on "The Boy Who Goes Wrong" which H. Addington Bruce, a well-known writer on psychological topics, published not long ago in the Century Magazine. After alleging that the boy who goes wrong does so because he is not properly brought up, Mr. Bruce quotes with approval the following passage from "Dr. Paul Dubois, the eminent Swiss physician and philosopher:

"If you have the happiness to be a well-living man, take care not to attribute the credit of it to yourself. Remember the favorable conditions in which you have lived, surrounded by relatives who loved you and set you a good example; do not forget the close friends who have taken you by the hand and led you away from the quagmires of evil; keep a grateful remembrance for all the teachers who have influenced you, the kind and intelligent schoolmaster, the devoted pastor; realize all these multiple influences which have made of you what you are. Then you will remember that such and such a culprit has not in his sad life met with these favorable conditions; that he had a drunken father or a foolish mother, and that he has lived without affection exposed to all kinds of temptation. You will then take pity upon this disinherited man, whose mind has been nourished upon malformed mental images, begetting evil sentiments such as immoderate desire or social hatred."

ENVIRONMENT MISUNDERSTOOD

It is a thankless task to have to destroy such pretty sentimentality, but its prevalence is doing far more harm in the world, I dare say, than all the forces of charity and philanthropy can correct. Mr. Bruce indorses this kind of talk when he concludes, "The blame for the boy who goes wrong does not rest with the boy himself, or yet with his remote ancestors. It rests squarely with the parents who, through ignorance or neglect, have failed to mold him aright in the plastic days of childhood."

Where is the evidence of the existence of these plastic days of childhood? If they exist, why do not ordinary brothers become as much alike as twins, during them? How long are we to be asked to believe, on blind faith, that the child is putty, of which the educator can make either mediocrity or genius, depending on his skill? What does the environmentalist *know* about these "plastic days?" We long ago gave up expecting that Mr. Bruce and his friends would bring forward any proof that there was such a thing, but we still hope that they may learn to interpret their own facts in the light of knowledge, not dogma. If a boy has a drunken father or foolish mother, does it not occur to them that there is something wrong with his pedigree? If much of it is like that sample, we do not expect him to turn out well, no matter in what home he is brought up. If a boy has the kind of parents who bring him up well; if he is, as Dubois says, surrounded by relatives who love him and set him a good example, we at once have data for a suspicion that he comes of a pretty good family, a stock characterized by a high standard of intellectuality and morality, and it would surprise us if such a boy did not turn out well. But he turns out well because what's bred in the bone will show in him, if it gets any kind of a chance. It is his nature, not his nurture, that is mainly responsible for his character.

Such is our conclusion, based on a great many facts of the kind I have presented to you here this evening. We have never found a fact that has contradicted this conclusion. If anyone has ever found such a fact, I do not know of it. He will make himself famous if he will give it publicity.

We do not for a minute desire to depreciate the importance, the necessity of a good environment. If it is not good, and equally good for every man, then some men's good hereditary traits will fail to get expression, we will not

know what they are really worth, and eugenics will lose valuable material that it needs. We want the best environment that science can create, but we shall not ask it to make good heredity out of bad, because it can not do so. Our desire is rather to give it as large a supply as possible of good heredity with which to work. Karl Pearson has effectively stated the eugenist's attitude in his allegory of a certain workman who found his chisel ineffectual. "He hardened it and he tempered it, and he gave it a cutting edge on the grindstone, and he finished up on the oilstone. Then he tried his chisel again and in ten minutes it was as ineffectual as before. Then he repeated the whole process and again the chisel failed him. Then he proceeded to 'turn up' his grindstone and replaced his oilstone by an American product, but all in vain; the chisel still refused to do efficient work. Just as he was proceeding to the process of 'hacking' his grindstone and to trying a brand-new German hone, a fellow workman suggested that the *steel of his chisel might possibly be at fault.* Instead, however, of proceeding to test the amount of carbon in his steel, or to try his workshop appliances on another chisel, our first workman grew angry and asserted that his colleague was neglecting all the resources of modern technology, all the advances of applied science. If hardening and tempering, if grindstone and oilstone were idle, we might as well throw aside all mechanical progress and again make our tools by chipping flints."

What, after all, should be our policy of social improvement? Is heredity everything and environment a superfluity? Is improvement of social conditions a waste of time? "Are we then to discard the methods of civilization, to describe as worthless the whole field of liberal and social reform," because we find that the force of heredity is so much greater than the force of environment? "Are we to throw aside the oilstone and break up the grindstone because they cannot make bad steel into an effective tool? Surely they are necessities for the proper working of a good tool. The mistake in our social policy has been that we supposed them primary and not secondary, that we thought to advance the nation by legislation which has hampered nature, to provide nurture for the feeble, for the inherently weak stock, the steel of which grindstone and oilstone will and can make nothing."

We will not sacrifice any of the good parts of our present social fabric; but we must have a nation with a higher level of heredity, to make the best possible use of this social fabric.

NEW PUBLICATIONS

HEREDITY AND ENVIRONMENT IN THE DEVELOPMENT OF MEN, by Edwin Grant Conklin, Professor of Biology in Princeton University. Pp. xiv+533, price $2 net. Princeton, New Jersey, The Princeton University Press, 1915.

Chosen to deliver the N. W. Harris lectures at Northwestern University last year, Professor Conklin discussed at length the subject of human genetics, from the standpoint of a cytologist, and has now published these lectures in the form of a book, which discusses the practical application of a knowledge of development to the human race. The first 187 pages explain the biological foundation of eugenics, in the cell and its development; the next 206 pages review our present knowledge of the phenomena of inheritance; the influence of the environment is then discussed and its great importance emphasized by an appeal to the facts of development, which many genetists are prone to overlook; the eugenics movement and its ethical basis occupy the remainder of the book, save for a useful bibliography and glossary. It can be recommended without qualification to anyone who wishes to gain a sound knowledge of the biological basis of eugenics—and that ought to include every one seriously interested in the subject.

The

Journal of Heredity

(Formerly the American Breeders' Magazine)

Vol. VI, No. 6 June, 1915

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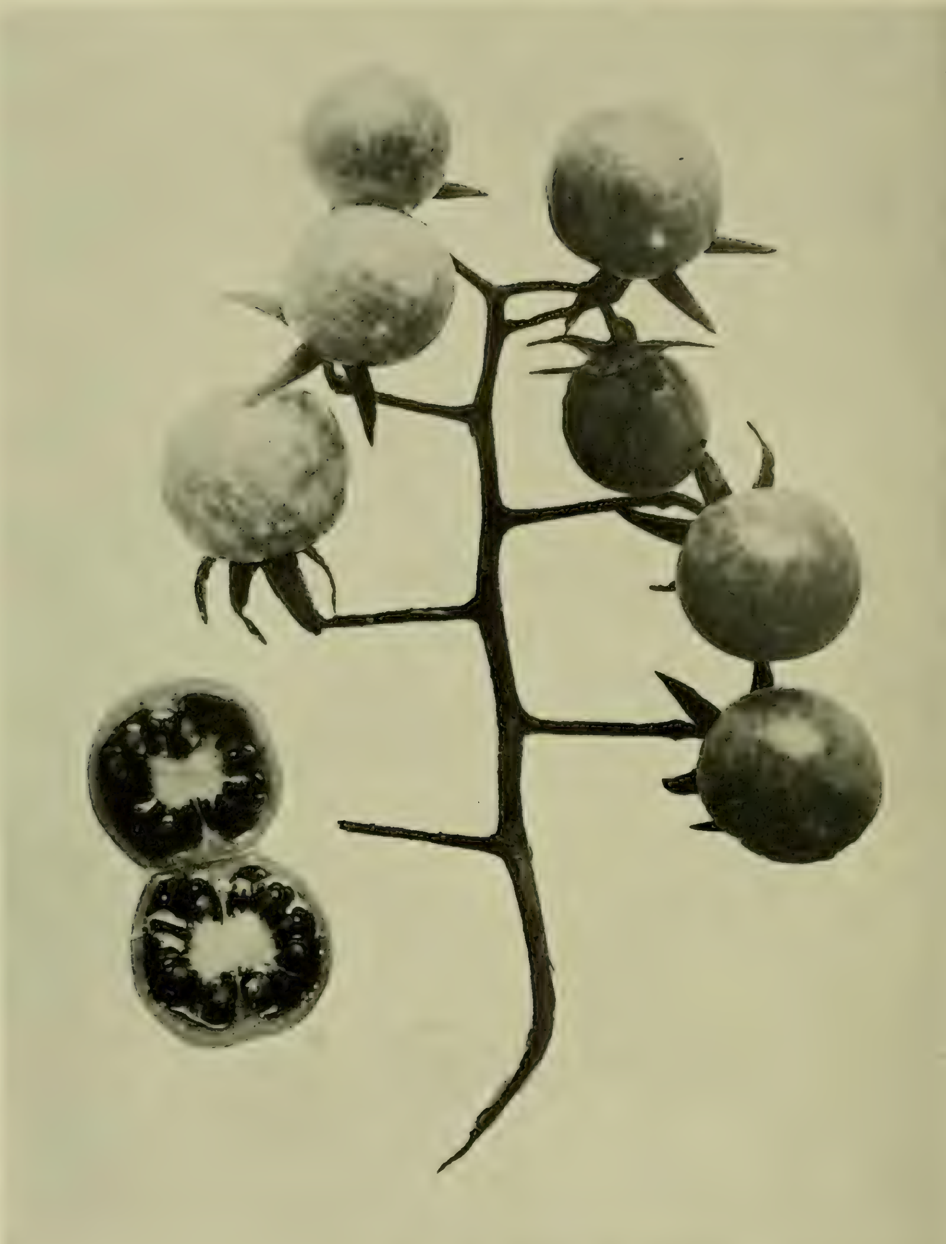
The Journal of Heredity is published monthly by the American Genetic Association (formerly called the American Breeders' Association) for the benefit of its members. Canadian members who desire to receive it should send 25 cents a year, in addition to their regular membership dues of $2, because of additional postage on the magazine; foreign members pay 50 cents extra for the same reason. Subscription price to non-members, $2.00 a year, foreign postage extra; price of single copies, 25 cents.

Entered as second-class matter February 24, 1915, at the postoffice at Washington, D. C., under the act of August 24, 1912.

Date of issue of this number, May 25, 1915.

THE WILD TOMATO



The little wild tomato (*Lycopersicum vulgare cerasiforme*) which is found in Madeira is generally considered by botanists to belong to the original stock, native in South America, from which our cultivated varieties have been derived. It grows wild in many parts of the islands, often under desert conditions, and in appearance the plant is quite similar to the garden varieties. One plant was found where it could not have had a drop of water for at least three months. It probably had started to grow during the last few rains of spring, but had completed its growth during the heat and drought of summer. When it was found, the vine was apparently dead and lying flat on the ground; the leaves had dried up and dropped off; but more than 300 fruits, all plump and firm, were clinging to the vine. The fruits are so very acid that they can be used for little else besides soups, and the natives do not use them a great deal for even that. Their keeping quality, however, might prove a desirable characteristic in crossing with some of the highly developed varieties with the object of obtaining a good shipping tomato of pleasing flavor. Photograph, actual size.

(Frontispiece) CHARLES H. GABLE, *Funchal, Madeira.*

POLLEN STERILITY IN GRAPES

Some Varieties Self-sterile—Study of Pollen Shows That It Becomes Worthless through Degeneration of Cell-nucleus—Remedy in the Planting of a Mixture of Varieties in the Vineyard.

M. J. Dorsey

University of Minnesota Agricultural Experiment Station, University Farm, St. Paul, Minn.

A NUMBER of varieties of grapes fail to set fruit when pollinated with their own pollen. This fact has been observed by grape growers for some time, especially when large blocks of certain varieties have been grown in more or less isolated positions. The reason for this has been given careful study by Beach ('98 and '99) and Booth ('02) working at the New York State Experiment Station. Munson ('09) in Texas and Whitten ('99) in Missouri have also contributed much in this work. Later, working in North Carolina with some of the southern grapes, Reimer and Detjen ('10) showed that a similar condition with respect to sterility existed in a number of these varieties. These have been the important attempts to determine which varieties will fruit when standing alone.

Testing Sterile Varieties: A brief statement, setting forth the main facts developed in their work will be interesting in this connection. Tests were made of the ability of a large number of varieties to set fruit when pollinated with their own pollen, by enclosing clusters in paper bags before the blossoms opened. In those varieties which are self sterile, pollen is produced in the usual quantities so that the failure to produce pollen is eliminated as a reason for sterility. An interesting fact developed in this bagging work was that pollen from those varieties which failed to set fruit when self pollinated also failed as an effective pollenizer when used on other varieties. These facts show that sterility in the grape is due to a lack of functioning in the pollen rather than in the pistil.

To illustrate from the work of Beach, when 143 clusters of Brighton were covered with bags and self pollinated, the average rating of the clusters formed, counting 100 as a perfect cluster, was approximately one, and, when thirty-two clusters distributed among 8 other varieties were pollinated with Brighton pollen, the average rating was three, showing Brighton, for those varieties used, as well as for itself, to be a poor pollenizer. On the other hand, when 116 clusters of Catawba were selfed, the average rating on the same basis as above was eighty-six, as compared with one in Brighton. When thirty-three clusters of eight other varieties were pollinated with pollen from Catawba, the average rating was sixty-seven, showing a marked difference between the Brighton pollen and the Catawba pollen when used either in selfing or crossing.

EXPERIMENTAL EVIDENCE

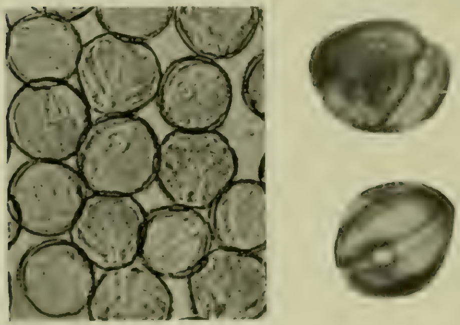
Beach worked with a large number of varieties and by means of the bagging method classified them with respect to their ability to fertilize themselves and also as cross pollenizers. Figs. 1 and 2 show two mature clusters of Brighton, illustrating the result when this variety is self-pollinated and when it is fecundated with the pollen of some other variety.

Reimer and Detjen ('10) extended this information and showed a similar condition to exist in a number of varieties of *Vitis rotundifolia* grown in the South.

Booth ('02) showed that the pollen from self sterile varieties was markedly different, when dusted upon a slide and examined with a microscope, from the

THE PROBLEM OF GRAPE POLLINATION

In many vineyards a poor crop of grapes is obtained, because the flowers are not properly pollinated. Many varieties are self-sterile, and must be pollinated with pollen from the flowers of some other variety; if there is no other variety bearing potent pollen near at hand, this does not take place, and the crop is a failure, as graphically shown in these two photographs. The one above shows a bunch of Brighton, a self-sterile variety, which has been pollinated only from its own pollen; on the opposite page is a bunch of Brighton cross-pollinated from another variety. Photographs from U. P. Hedrick, Geneva, N. Y. (Figs. 1, 2.)



NORMAL GRAINS OF GRAPE POLLEN

At the left, photomicrograph of a quantity of potent pollen grains from the variety Clinton, mounted in lactic acid; at the right, external view of the suture and germ-pore of fertile pollen from a staminate vine grape of the wild-river bank (*Vitis vulpina*). Each pollen grain, when dry has three longitudinal folds or sutures in the thick outer covering and when it is put in water these unfold and the grains often become twice as large as when dry. (Fig. 3).

normal fertile pollen. The normal pollen is oblong in outline with slightly flattened ends when dry, while the sterile is quite irregular and folded. By careful experiments he showed that the irregular grains, whether occurring mixed with the normal grains or not, failed to germinate when placed in a nutrient sugar solution. As a result of this work it is possible to tell whether a new variety is self sterile by means of a microscopic examination of its pollen.

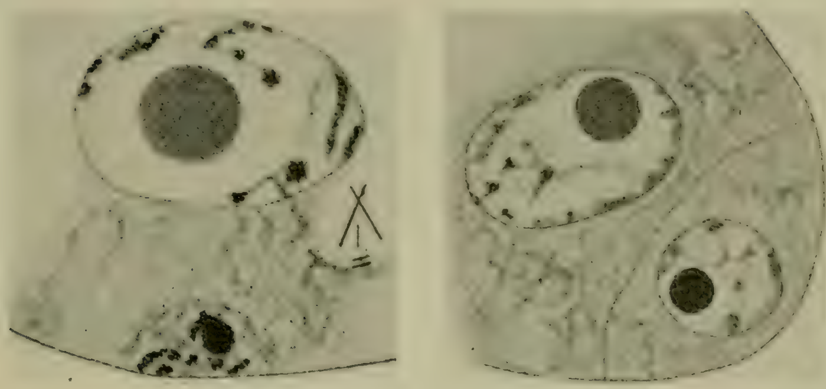
Flower Types: As is well known, there occur in the grape three types of flowers, (1) those with stamens upright and pistils abortive (this type of flower is functionally staminate), (2) those having upright stamens and pistils fully developed and functional (the perfect flowers), and (3) those with reflexed stamens containing sterile pollen and fully developed pistils (functionally the pistillate flowers). While the cultivated varieties quite generally produce functional pistils, there are, however, occasional vines found which have only a partial development of the pistil. The writer ('12) showed that, with respect to pistil development, practically a complete series of intermediates occur between those forms which are classified as staminate and those classified as pistillate.

A classification based upon stamen type, of 132 important commercial varieties, shows that there are ninety-five varieties with upright and thirty-seven with reflexed stamens. Of the ninety-five only eleven are classed as self sterile or partly so, while only two of the thirty-seven having reflexed stamens were partly fertile, the remainder being sterile.

SUMMARY OF RESULTS

These results may be briefly summarized as follows: (1) Self sterility in the grape is due to the pollen. (2) All varieties tested set fruit when potent pollen was used, which shows that the pistils are normal. (3) Certain varieties are more effective as pollenizers than others. (4) When dry, potent pollen can be distinguished from impotent by its shape. (5) Impotent pollen is correlated with the reflexed type of stamen.

The Nature of Sterile Pollen in the Grape: It will be interesting, now, since it has been shown that the pollen borne by a number of American varieties of grapes is more or less impotent, to



WHY SOME POLLEN IS WORTHLESS

Careful study has shown that in most instances the inefficacy of pollen is due to the fact that the generative nucleus in each cell has degenerated. At the right is a camera lucida drawing of part of a pollen grain of the variety Concord, showing both nuclei normal. The vegetative nucleus, at the top, plays its part in producing the pollen tube, after the pollen grain falls on the stigma and starts to germinate. Down this tube the nuclei formed by a division of the generative nucleus, in the lower part of the figure, will pass, one of which will unite with the egg-cell nucleus to begin the formation of the seed. At the left is shown part of a Brighton pollen grain, in which the vegetative nucleus is normal but the generative nucleus has degenerated. (Fig. 4.)

determine the nature of this impotency. This has been the subject of some investigations by the writer in the past few years and by careful examination of pollen development in both sterile and fertile forms some interesting facts have been developed. (Dorsey '14.)

These studies have been carried forward by means of the usual cytological technique and have involved a careful study of pollen development in both the sterile and fertile forms. Particular attention has been given to a study of (1) aborted pollen and (2) the degeneration of the nuclei in the mature pollen.

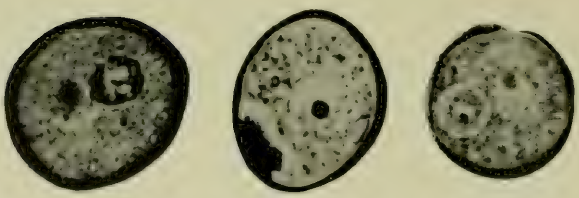
It might be well before taking up a consideration of these two topics to state briefly the stages in pollen development which take place normally. Early in the spring the tissues of the anther differentiate and produce pollen mother cells. These undergo further growth and differentiation, passing through stages well known in the higher plants. The pollen mother cell divides and then divides again, so that we have produced from each pollen mother cell four nuclei. From these, the so-called microspores are formed. These young microspores, or one-celled pollen grains, undergo a period of growth and enlargement and are finally separated; the nuclei of these pollen grains again divide, forming the mature pollen grain with two nuclei, the smaller one of which is the generative nucleus, which by another division forms the gametes.

POLLEN DEGENERATION

Up to the formation of the microspores, development apparently takes place normally in the self sterile varieties. We shall consider the aborted pollen and degeneration of the nuclei in the mature pollen.

The Aborted Pollen: An examination of the pollen in the mature anthers of a number of varieties, both cultivated and wild, showed that aborted pollen is produced in varying quantities. In some varieties, this amounted to as much as 69% of the pollen produced, while in others there were practically no aborted grains. The aborted pollen was found in both self sterile and self fertile varieties and was produced in practically equal quantities in the wild staminate and pistillate vines of *Vitis vulpina*.

No abortion of pollen grains has been noticed in the grape previous to the



DEGENERATION OF GENERATIVE NUCLEUS

(a) Pollen grain of Brighton, in cross-section, showing commencement of degeneration in the generative nucleus (at the left). (b) Grain of same variety, in which the generative nucleus has wholly degenerated, and the vegetative nucleus is still functional. (c) Normal pollen grain of the wild grape, *Vitis Vulpina*, shown for contrast. Both nuclei here are still functional. Photomicrographs. (Fig. 5.)

liberation of the microspores from the common mother cell. It is first noticeable during the early growth period of the free microspore and shows various degrees of arrested growth combined with loss of cytoplasm.

This aborted pollen, however, does not seem to be important from the standpoint of the setting of the fruit, since there is an abundance of pollen produced and even in the instance cited, where 69% of the pollen produced was of the aborted type, still there would be enough normal pollen, if potent, to insure a good setting of fruit.

The Degeneration of the Nuclei: In the mature pollen grain we have two nuclei, the generative and the vegetative. The generative nucleus, as has been stated, divides again to form the gametes, and the vegetative nucleus functions in the growth of the pollen tube. These two nuclei are shown in figure 4, the smaller one being the generative nucleus. A careful study of the pollen, produced by those varieties which bagging tests have shown to be more or less self-sterile, shows that the generative nucleus, and in some cases, also the vegetative, degenerate, as shown in figures 4, 5, and 6. Such degeneration precludes the possibility of normal functioning in any pollen where it occurs. These studies show that degeneration in both nuclei occurs in a large per cent. of the pollen in Brighton, while in other varieties which are self fertile, normal pollen (fig. 5c) is produced. Sterile pollen in the grape, then, is due to degeneration in the generative nucleus.

The Germ Pores: Another fact which is interesting in this connection is that the germ pores (Fig. 3) are not formed in pollen borne by the reflexed type of stamen. There is an interesting correlation, then, in the absence of the germ pore, sterile pollen, the reflexed type of stamen, and the tendency toward dioeciousness.

The general question of sterility in plants at the present time is being investigated from a number of standpoints. It has been known for a long time that a good many hybrids are sterile. Some workers, particularly Jeffries, have emphasized the relation between aborted pollen and hybridity. A number of cases are recorded where an unequal number of chromosomes are brought into the zygote from each parent. This is not the case, however, in such varieties as Brighton and Barry, which, like Concord and *V. vulpina*, have twenty chromosomes in the reduced number. From the heredity standpoint some workers hold that sterility results from the presence of a factor for sterility. The physiology of pollen growth and fertilization is now being investigated and it is probable that some interesting things will be discovered from this standpoint. All told, the influences leading to sterility are not well understood and we shall have to reserve judgment on a number of points until further work has been done.

DEGENERATION OF BOTH NUCLEI

In some cases both nuclei of the pollen grain degenerate. At the left is a photomicrograph of a pollen grain from Brighton, in which this has taken place; at the right is a camera lucida drawing much more enlarged of the same process, in another grain of the same variety. Note irregular shape of both nuclei. (Fig. 6.)

Finally, then, in the case of the grape, if sterility results from degeneration in the generative nucleus which prohibits normal functioning of the pollen, it is clear, that to overcome the defects of self sterility in any variety, it will be necessary to continue the practice firmly established by some of the earlier workers of mixing varieties in the vineyard.

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Great Men and How They Are Produced

In order to call attention to his offer which is now in the hands of the American Genetic Association, Casper L. Redfield (Monadnock Block, Chicago, Ill.) has issued a pamphlet with the title "Great Men and How They Are Produced." It gives partial genealogies for 571 eminent men, showing that in most cases such men are the product of slow breeding—that is, with an unusual amount of time between generations. Mr. Redfield has offered two prizes of $100 each to the American Genetic Association, if any one can bring forward instances of really great men produced by rapid breeding. The offer remains open until December 31, 1915, and its details can be learned from the Journal of Heredity, July, 1914, or from Mr. Redfield or this Association.

WELLESLEY'S BIRTH-RATE

Reproductivity of College Graduates Far from Adequate Even to Replace Their Own Numbers—Importance of the Problem and Suggestions for Its Solution.

Roswell H. Johnson and Bertha Stutzmann
University of Pittsburgh, Pittsburgh, Pa.

No question is of greater importance to eugenics than that of the birth-rate among the eugenically superior parts of the population. The junior author has therefore been investigating the reproductivity of Wellesley College graduates; some of her data were presented by the senior author in his address on Marriage Selection before the Race Betterment Conference at Battle Creek, Michigan.[1] This investigation has now been completed, and the results are summed up in the following table:

WELLESLEY COLLEGE

Status in fall of 1912	Graduates	All Students
Per cent. married (graduated 1879-1888)	55%	60%
Per cent. married in:		
10 years from graduation	35%	37%
20 years from graduation	48%	49%
Number of children (mothers graduated 1879-1888):		
Per student	.86	.97
Per wife	1.56	1.62

From a racial standpoint, the significant marriage rate of any group of women is the percentage that have married before the end of the child-bearing period. Classes graduating later than 1888 are therefore not included in the first case, in which the status is of reports in the fall of 1912. In compiling this data deceased members and the few lost from record are of course omitted.

It is desirable to find any change that may be taking place in the marriage or birth rates, so we have calculated the rate at the end of ten and twenty years after graduation for each class. The twenty-year period so nearly covers the effectively fertile years of a woman's life that it is more significant than the unlimited rate of the '79-'88 classes. The result destroys the defense put forward by certain apologists for separate colleges, viz.; that the earlier college women were more professionally inclined, that their marriage rate was abnormally low for this reason, and that with the more varied classes of later years, the marriage rate must have risen. Let us hope there has been a change for the better in the uncharted last ten years: but there is nothing in the steady decline of the previous years to give any confident basis for such a hope.

In the address referred to above, statistics were given showing a lower reproductivity[2] of the honor girls (Phi Beta Kappa) resulting principally from a lower marriage rate. In order to test this further, we give the results of an

[1] Journal of Heredity, V, 3, pp. 102-110, March, 1914.

[2] The word *reproductivity* is used as a convenient term to give the net result as expressed in number of children per total number of women married or unmarried.

investigation of the honor girls before Phi Beta Kappa was established at Wellesley. These honors consisted of Durant and Wellesley scholarships, which carry no stipend and are therefore awarded by the faculty solely for excellence in studies. The previous findings in regard to Phi Beta Kappa girls are confirmed by this newer study, as follows:

WELLESLEY COLLEGE

GRADUATES OF '01, '02, '03, '04, STATUS OF FALL OF 1912

	All	Durant or Wellesley Scholars
Per cent. married	44	35
Number of children:		
Per graduate	.37	.20
Per wife	.87	.57

The extraordinary inadequacy of the reproductivity of these college graduates can hardly be taken too seriously. These women are in general, and from a eugenic point of view, clearly of superior quality, for

(a) They have survived the weeding-out process of grammar school and high school.

(b) They have survived the repeated elimination by examinations in college.

(c) They represent the number left, after those with lower mental abilities have grown tired of the mental strain and dropped out.

(d) Some have forced their way to college against obstacles, because seeking its mental activities, congenial to their natures.

(e) Some have gone to college because their excellence has been discovered by teachers or others who have strongly urged it.

All these attributes cannot be wholly mere acquisitions, but must be in some degree inherent. Furthermore, these girls are not only superior in themselves, but are ordinarily from superior parents, because

(a) Their parents have in most cases cooperated by desiring this mental training for their daughters.

(b) The parents have in most cases had sufficient economic efficiency to be able to afford a college course for their daughters.

Now, these select women, who should be having at least the 3.7 children each, which Sprague[3] calculates are necessary to maintain a stationary population, are only giving to the race .83 of a child each. Their reproductivity is only 22¼% of being adequate merely for replacement.

There are at least three causes for this abnormally low birth-rate, viz.:

(1) Lack of coeducation.

(2) The failure of their education to make them desirous of having homes of their own and efficient in these homes.

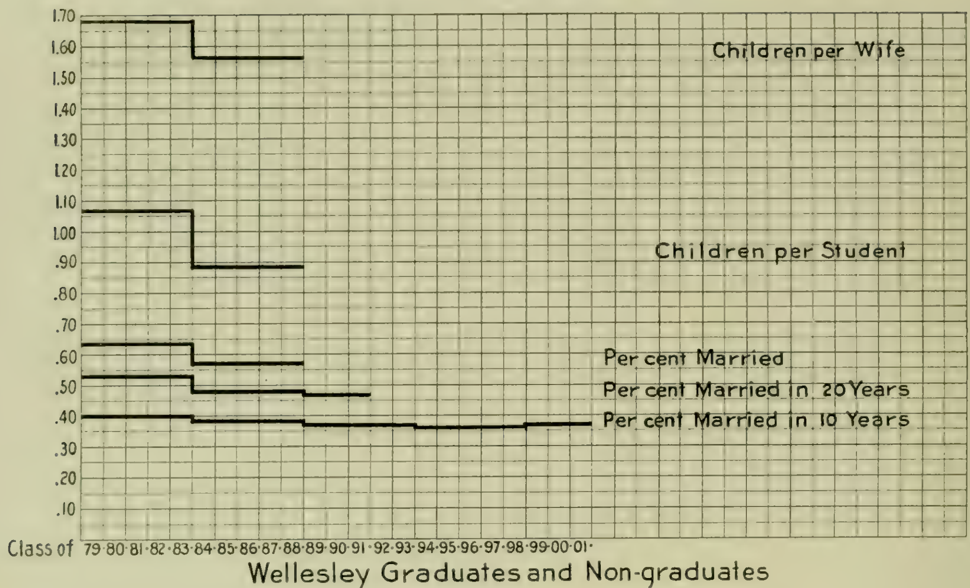
(3) Excessive limitation of the students' opportunities for social life.

Sprague expresses a doubt whether any adequate data in regard to the influence of coeducation on the marriage and birth rates have yet been collected. But we see no reason for rejecting the results of Miss Shinn's investigation (*Century Magazine*, October, 1895), desirable as further studies may be. She found that nearly 50% of the coeducational women married before the age of 30, but only 40% of the women from separate colleges. If one thinks this difference small, let him remember that even 1%, carried over a long period of time, would produce a great effect in a cumulative process such as evolution.

Furthermore co-education produces a larger percentage of marriages with college men.

Separate colleges for women, in the United States, are from the viewpoint

[3] Sprague, Robert J., Education and Race Suicide. JOURNAL OF HEREDITY (Organ of the American Genetic Association), Vol. VI, No. 4, pp. 158-162, Washington, D. C., April, 1915.



Graph showing at a glance the record of the student body in regard to marriage and birth rates, during the years indicated. Statistics for the latest years have not been compiled, because it is obvious that girls who graduated during the last fifteen years still have a chance to marry and become mothers. (Fig. 6.)

of the eugenist an historic blunder. They arose because (1) women were debarred from the eastern men's colleges —a most unfortunate circumstance, (2) because the mental capacity of women was at that time all too frequently considered to be too inferior for college training. It was, therefore, a natural result that colleges for women should be established. But, unfortunately, to correct the current depreciation of woman's mentality, it was thought necessary to give her the same curriculum as that used by men.

The results of the experiment, however, have been utterly inconclusive because no direct comparison of the men and women was possible. It was in the coeducational colleges that the test was conducted under satisfactory conditions. Today it is well known that the women capture more than their proportion of the honors and average higher in their marks. Is there any real reason, then, for these eastern, separate, women's colleges to continue along the same old lines, with the unsatisfactory results that we have seen?

The stubborn resistance of these colleges to the introduction of education for domestic efficiency, especially in the care of the infant, has been amazing. They are thereby neglecting one of the most important factors in a woman's sound education.

May it not be that this ill-adjusted education is partly responsible for the fact that Cattell finds in American men of science at the time of his inquiry that those having college graduates as wives had 2.02 children each, while those with wives of partial college training had 2.12 children and those with wives of no college education 2.35 children?

The very proper preference in many intelligent men for girls trained to be efficient wives and mothers is one of the causes of the low marriage rate and late time of marriage of the graduates of the women's colleges. The trained girl can and will marry a man with an income too restricted for the support of an inefficient wife.

Rules in force at various women's colleges, which lead to social limitations, not to say asceticism, throw up

barriers to the social opportunities of the students. And this during the critical years of maximum attractiveness when, as we have elsewhere shown, so many of the non-collegiate girls are marrying or making acquaintances leading to marriage. To take a specific instance: at Wellesley no young men are allowed to call on a student during her one free day, Sunday.

Since, then, the separation of sexes in different colleges, and the failure to teach girls domestic science, are contrary to the interests of society and the race, should we not urge:

(1) Parents to send their daughters to coeducational universities, or at least to semi-coeducational ones such as Harvard and Columbia where they will have some opportunity to meet superior young men.

(2) The state or private benefactor to provide all men's colleges with closely affiliated women's colleges and all women's colleges with closely affiliated men's colleges, and to provide all women's colleges with strong departments for the teaching of domestic science in the broadest sense of the term. In case of refusal of the institution to accept such provisions, discrimination in the distribution of funds might well be made in favor of the more soundly organized institutions.

Conformation of Cows and Milk Yield

Inquiry into the relation between conformation of cows and milk yield has lately been made by J. Reimers, an agricultural teacher at Wageningen, Holland, and his conclusions were summarized in the *Mitt. der Deut. Landw. Gesell.*, for April 26, 1913. The data investigated by him were taken from the Friesian Cattle Herd Book, and had reference to 300 animals, from 2¼ to 3 years old. With regard to the statistical methods adopted, it may be explained that he divided the animals with milk yields between 4,400 pounds and 8,800 pounds into five classes, and attempted to correlate the yields with the various features of the conformation. He also divided the animals into classes according to their body measurements, and attempted to correlate these with the milk yields.

The investigators' findings, when summarized, were, generally, to the effect that no relationship existed between conformation and milk yield. His conclusions were as follows:

The milk yield increases slightly with increasing *length of body* until the latter reaches a certain point, after which there appears to be a slight decrease in the yield. Abnormal length of body apparently has the effect of lowering the milk secretion.

The milk yield increases with increasing *height of crupper*; but the increase can by no means be called regular, and a strong connection between the two factors could not be established.

Animals with small or with very deep breasts appear to give a smaller yield than animals which are normal in this respect, but the difference was too slight to make the deduction of practical value.

There is no regular relationship between milk yield and *length of hindquarters*, or *width between haunches*, or *breadth of pelvis*. Animals with normal breadth of pelvis give more milk than those with larger or smaller breadth of pelvis, but the difference is not important.

The system followed by herd book inspectors, in awarding points for conformation, was also taken as a basis of comparison. No more success was met with in this direction, except, of course, in the case of points for udder, teats, milk veins, and similar indications of good milk yield. In the Friesian Herd Book as many as twelve points are awarded for shape of hindquarters, but no relation between this and the milk yield could be traced. Further, the best milkers had the worst thighs (although there was no regular connection between this and the yield).—Journal of Board of Agriculture (England).

DYNAMIC EVOLUTION

Redfield's Theory of Inheritance of Results of Training and Use Not Supported by Adequate Biological Evidence.

A Review by Raymond Pearl
Biologist, Agricultural Experiment Station, Orono, Maine

THAT "dynamic" should appear as an integral part of the title of a book by Mr. Redfield is altogether appropriate.[1] As a writer he is nothing if not forceful. He has (by right of training and experience) all of the good lawyer's skill in carrying the reader deftly across weak places in the logic of the argument or over lacunae in the factual basis, by means of a flow of vigorous and sometimes brilliant rhetoric. His writings have been followed with great interest by the present reviewer for ten years or more past. The occasion of that interest, however, has not been primarily genetics, but rather the psychology of scientific paradoxy. De Morgan's most delightful "Budget of Paradoxes" dealt with those ancient and honorable paradoxers who squared the circle, made machines calculated perpetually to move, and engaged in similar activities. In his day the biological paradoxer had not yet appeared in numbers, and the genetic paradoxer was totally absent. It would have delighted De Morgan beyond measure to have dissected Mr. Redfield's biology and through the maze of specious verbiage shown, at point after point, where that author's methods of scientific reasoning and proof deviated from those of his more orthodox colleagues.

As a scientific investigator Mr. Redfield labors under at least one very serious handicap. It is that he is firmly committed to a thesis in advance of the investigation. This assertion he would no doubt deny vigorously. I am entirely willing to rest my case as to its validity on the sum total of Mr. Redfield's writings on heredity and related topics.

It would be difficult to state briefly this thesis in terms which would be entirely acceptable (I fear) to its author. I shall therefore merely try to state my understanding of it in ordinary terminology. It is essentially this: that as any organ of the body, or the body as a whole, or the mind, is used or exercised there results, in some manner not made clear physiologically, an accumulation or storage of energy in the germ cells with respect to the organ or function exercised. This accumulation of energy (with respect to a particular character) is then supposed to be transmitted to the next generation, again by some process not made clear physiologically, but according to definite rules. These rules of transmission, while always definite, have been variously and sometimes curiously modified in the course of Mr. Redfield's writings upon the subject. The practical moral for the breeder, however, is in general, that in breeding for performance of any sort it is wise to use as breeders individuals which have been "developed" and hence have stored energy. Further, this will in general mean (though Mr. Redfield's latest codification of the rules of energy transmission by sex, etc., etc., makes a perfectly general statement of his precepts impossible in few words) that the parents of great performers are likely to be found amongst relatively aged animals.

The present book is essentially a condensed epitome of the author's earlier writings upon this subject which

[1] Dynamic Evolution. A Study of the Causes of Evolution and Degeneracy. By Casper L. Redfield. New York and London (G. P. Putnam's Sons), 1914. Pp. 210, price $1.50 net.

have been published in various journals devoted to live-stock or fancy breeding interests. He has applied his thesis to trotting horses, setter dogs, Holstein cattle, and human beings. The first fourth of the book is devoted to an exposition of the theory in general terms. The discussion is of a most fundamental character. It has as its only initial assumption existence of matter and energy. From that somewhat unpromising, or at least very raw, material there is developed in some fifty odd pages, by pure ratiocination, a full blown theory of heredity.[2] This theory consists essentially of the thesis which has already been outlined. The attempt to ground it on elementary principles of physics and pure logic need not detain us.

The rest of the book is nearer the ground. It consists in an application of the theory to selected facts in the breeding history of the animal forms mentioned in the preceding paragraph. Mr. Redfield apparently regards these chapters as an exposition of the results of different tests of the validity of the theory. In any sense which a trained scientist would regard as critical none of the material presented can be looked upon as furnishing a definite test of the theory.

It would require altogether too much space to discuss critically all the points of alleged fact and their interpretation brought out in this book. It will perhaps be more useful to point out wherein the methods of "investigation" followed in general by Mr. Redfield seem to be faulty. In the first place our author apparently has no conception of the meaning of random sampling and the errors connected therewith. Many of his comparisons are essentially statistical in their nature, but there is not a "probable error" in the book. Thus on p. 85 he tables the mean age of fifty-eight sires of 2:10 stallions in the following way:

Sires of 2:10 *Stallions*

45 Sires with records, average age	9.8 years
13 Sires without records, average age	13.6 years
58 Sires of Stallions, average age	10.71 years

He then shows that the mean age of 1,000 trotting horse sires in general (presumably a random sample, but this is not entirely clear) is 10.43 years. I leave these figures to the consideration of the biometrician, with only the additional quotation of Mr. Redfield's comment upon the table: "The striking thing about the above table is the fact that one group of sires falls below this (the general) average while the other group is considerably above it. As age means time, and time is a factor of energy and not of anything else, any variation, other than a mere accidental one, in the average age of a group of sires from the normal average, has reference solely to work performed by those sires before reproduction. Whether the present variation is due to accident or to the operation of a law of nature we may determine by examining the sires in detail and learning what relationship existed between the ages of the different ones and the work they performed."

To speak about laws of nature on such a basis of fact is, to put it quite mildly, a thoroughly optimistic piece of business.

CONTRADICTIONS DISREGARDED

In the second place all unconformable facts, and all ways of looking at the facts different from the author's way are totally disregarded. For example, in the discussion of Laverack's setters the results which that breeder got are interpreted as solely due to the fact that he hunted his dogs and bred them relatively late in life. There is not the slightest real evidence that either of these two things had any more than a very minor part, if any, in accounting

[2] Incidentally in the process there are chipped off some real gems of thought. I would especially recommend to the consideration of professional philosophers this last sentence on p. 3: "Causes are forces acting upon matter."

for his results, whereas all that we know from live-stock breeding history, and from experimental data, would indicate that the primary factor in Laverack's success was inbreeding. Whether or not this is true, in any event the whole course of genetic knowledge during the last fifteen years shows most clearly that it is not wise to insist on any one factor as the *exclusively* important one in interpreting natural evolution or breeding practice.

In the third place, the author is either grossly ignorant of the literature of biology and physiology or else feels impelled in his theorizing to soar above all paltry consideration of ascertained biological fact. There are few pages of the book which do not contain some statement, put in the form of a positive, dogmatic assertion, which either has no foundation in fact whatever because the subject has never been investigated, or is contrary to well-known data in the literature of biology. For example, to take a perfectly random chance, the place where the book falls open as I write these words is p. 145. In the middle of that page occurs this statement:

"The amount of butter fat produced by a cow depends upon two factors, one of which is the quantity of milk produced, and the other of which is the percentage of fat in the milk. Of these, *the percentage of fat is more highly variable than the quantity of milk* and is the more important factor in determining a cow's admission to the Advanced Registry."

For the portion of the statement in italics (mine) I know of no warrant in fact whatever. All the quantitative studies on the variability of milk which have ever been published, including those of Gavin, Pearson, and Vigor, show that quantity of milk is relatively (measured by coefficient of variation) more variable than per cent of fat, in the ratio nearly of 2 to 1.

On the inside front cover of each issue of this journal stands the following statement as to one of the objects of the American Genetic Association: "The Association constantly strives to further the cause of conservative, constructive science and to check the progress of fallacious and sensational pseudo-science." With the purpose of contributing in some small measure to the worthy object of checking the progress of pseudo-science this review has been written. Like all pseudo-science, Mr. Redfield's is a conglomerate mixture of the true, the false and the unknown. There undoubtedly *is* "something in it." There is, for example, an increasing body of evidence that there exists quite generally a correlation between birth order and certain other characters of the organism. In so far age of parents is to be considered as a factor to be regarded in an analysis of breeding results. But the methods by which it is sought to make it appear that this is a factor of overwhelmingly great importance, involving as they do all the discussion of the hereditary transmission of accumulated energy, do not form any part of what the reviewer understands as science.

Annual Meeting of A. G. A.

Plans are rapidly being completed for the annual meeting of the American Genetic Association at Berkeley, August 2–7. It promises to be one of the most successful yet held, in point of excellence of program. Members who may be going to the Pacific coast in the late summer are urged to arrange their itinerary so that they may be present at this meeting.

Eugenics Research Association

The Eugenics Research Association will hold its annual meeting at San Francisco August 2-5, in connection with the annual meeting of the American Genetic and other associations. Particulars can be obtained from the secretary, William F. Blades, Cold Spring Harbor, Long Island, N. Y.

THE MARRIAGE OF KIN

No Adequate Evidence That Any Evil Results from Consanguineous Matings, as Such, Although Where Both Stocks Are Weak the Offspring May Show Double Amount of Weakness.

EDWARD NETTLESHIP[1]
University of London, England

THE subject of marriage between blood-relations should, I think, engage the attention of all who are interested in problems bearing upon the improvement of the race; it is at any rate one upon which there has been, and perhaps still is, much diversity of opinion. Such differences of view are doubtless often based, on the one hand, upon the experiences of certain single families where serious defects or degeneracies have appeared in the offspring of consanguineous marriages, and on the other upon acquaintance with families in which nothing undesirable has followed the marraige of first cousins. Indeed those who object, from what we may call individual or single-family experience, would perhaps be surprised to find that the children of cousins sometimes showed a decided improvement upon their parents. In short I venture to think that the subject is one upon which we may well seek more knowledge and greater clearness of thought.

The fundamental questions are (1) whether the offspring of consanguineous parents display inferior or degenerate characters in larger proportion than do the offspring of unrelated parents? And (2), if such an effect can be shown, is the appearance of these undesirable characters attributable to something produced *de novo* by the union of parents related in blood, but who themselves contain no trace of such characters, either manifest or hidden? Or are the defects only a result of both parents being tainted, but not tainted badly enough to show?

The second question is not merely academic. For if consanguinity can produce something bad, good, or indifferent that had never occurred before in the genealogy then no cousin marriage is safe. But if it is only a case of inheritance from both parents, a tainted pair who have no community of blood will, so far as we know, be as likely to have undesirable offspring as if they were tainted cousins; whilst cousins who are free from taint will be expected to yield normal children.

It must be said at once that the data for answering the first question upon statistical grounds do not exist because no one up to the present time has been able to obtain sufficiently accurate returns of the relative numbers of consanguineous and unrelated marriages.

FREQUENCY OF OCCURRENCE

In 1862 a French writer, M. Boudin, came to the conclusion that close upon 1% of the marriages in France between the years 1853 and 1859 were between first cousins (counting in a few between uncle and niece or aunt and nephew.) And he considered that if second-cousin marriages had been included the total percentage would be 2% This conclusion was based upon the official records of more than twenty million marriages. It is obvious that such a return would err, if at all, on the negative side; especially in a Catholic country such as France was then. In the Roman Catholic Church marriage between near cousins is forbidden unless an indulgence be obtained by payment; and obviously the liability

[1] Dr. Nettleship died shortly after preparing this paper, which was published in the Eugenics Review, VI, 2, 130, London, July, 1914. It is here reprinted slightly abridged.

to such an exaction would sometimes lead to concealment of cousinship. Somewhat later returns (up to 1875) showed a rather higher proportion (1.5%) of first-cousin marriages, the consequence, apparently, of instructions from headquarters to make the enquiries more thorough. Further, M. Legoyt (Chief of the Statistical Department for France, quoted by George Darwin), at about the same date, came to the conclusion that the true percentage of first-cousin marriages for the whole of France was much higher than Boudin had supposed, viz., about 3%.

In 1875 George Darwin published a long and careful paper upon "Marriages of First Cousins in England and Their Effects." In this memoir the author made the important point that in England and Wales cousin marriages are probably much more frequent, relatively, in the aristocracy than in the general population, and least frequent in London. He estimated that 3.5% of aristocratic marriages were between first cousins, but only 1.5% of all London marriages. The paper was the outcome of great labor and care, but the exact figures of the cousin marriages were admittedly open to revision.

In 1908 Professor Karl Pearson made a limited contribution to the subject. He found that of 1,600 members of the medical profession no less than 4.5% had married first cousins, and that if the lesser degrees of consanguinity were included the total was 7.5%.

This 4.5% of first-cousin unions may be compared with Legoyt's estimate of about 3% for the whole of France, and George Darwin's 3.5% for the British aristocracy.

Pearson further, from an examination of the books of the hospital for sick children in London, found only 1.3% of cousin marriages of all degrees up to third cousins, recorded in the histories of 700 in-patients. This so far as it goes confirms George Darwin's conclusion that consanguineous marriage was relatively infrequent in London; but the family histories of these 700 hospital in-patients were probably far from complete in regard to the point and 1.3% is almost certainly too low.

DISCREPANCIES IN DATA

From these discrepant, and avowedly incomplete, materials it seems probable that a class or clan or caste influence operates in certain cases to produce a high proportion of consanguineous marriages, and therefore conclusions as to any effects of consanguinity, whether bad or good, drawn from a *mass* population would not necessarily apply to all the groups of which the population was composed. However this may be, one certainly finds that in some individual genealogies cousins often marry, and in others seldom or never.

As to the second question: Are the defects sometimes observed in the offspring of consanguineous parents due to the consanguinity as such or on the other hand to both parents being tainted?

In regard to the *de novo* origin of defects in children of cousin parentage we find Charles Darwin stating his belief as follows, after having devoted much attention to the subject: "I hope to show in a future work that consanguinity by itself counts for nothing, but acts solely from related organisms having a similar constitution, and having been exposed in most cases to similar conditions;" and a recent authority, Professor J. Arthur Thomson, of Aberdeen, considers that "the idea that there can be any objection to the marriage of two healthy cousins who happen to fall in love with one another is preposterous." Many similar, and also some, but I think a diminishing number of, opposing, opinions might be cited.

What then is the origin of the view, or at least the suspicion, held by many, that consanguineous unions are injurious as such?

Without going back to the very early history of marriage customs and prohibitions—a task I am not competent to undertake—it is I think enough to say that the early Christian Church appears to be chiefly responsible for the existing residue of prejudice against the marriage of cousins. The church put its ban upon consanguineous unions;

at first in connection with the cult of asceticism and celibacy, later because it was able by the sale of indulgences to make money by allowing consanguineous couples to break the Canonical rules for a consideration. That this was so is confirmed by the subsequent extension of the prohibitions to various affinities, or even accidental associations, between persons not related at all by blood.

Thus—to quote from Huth's "Marriage of Near Kin" (p. 122), (1887) —the council of Trent in the middle of the sixteenth century issued the monstrous declaration "that the person baptized, his *parents*, *god-parents*, and the *priest* who baptized him were as much inter-related as though they were relatives by blood to each other," so that, as the author continues, "no tolerably near relative of the priest could marry either the godrelations or relations of any child that priest had baptized;" and there is much more to the same effect. Without enquiring too closely as to whether such absurd regulations were always carried out we may, I think, safely agree with Mr. Huth when he says that "the prohibited degrees were far too useful to abolish."

GENETIC CONSEQUENCES

Of course other causes have been and are still at work in both encouraging and discouraging consanguineous marriages. Any such influences as may possibly depend upon supposed social inconveniences or inexpediencies arising from these marriages are outside my purview. I think the most operative cause of such hostility to these unions as still exists is the confusion, already referred to, between *inheritance* of a defect from two *slightly* tainted, but apparently normal parents and the supposed creation of an entirely new thing by union between those of related blood. Such confusion is only too natural, and all of us have, I daresay, fallen into the pit at times—certainly I have done so formerly. For instance, if amongst the children of a pair of seemingly normal cousins there should be some born deaf and dumb the calamity cannot be hidden from the friends, and, as casual enquiries about cause are seldom carried further back than the parental generation, as most of us have a fatal facility for stopping at the first plausible excuse, no surprise need be felt if the cousinship, as such, is blamed; although had enquiry been possible or been permitted, cases of the same malady would very likely have been discovered in ancestors or collaterals.

That consanguinity of parents repeated through many generations is compatible with the maintenance of a high standard of health and vigor (mental and bodily) is demonstrated by well-known instances.

Near the mouth of the river Loire, on the Atlantic coast of France, is the small Commune of Batz, situated on a peninsula that is almost shut off from the mainland by a salt-marsh, so that the inhabitants have (or had prior to 1864 when the investigation now referred to was made) very little communication with the people of the mainland. The principal occupation is salt-making; and the inhabitants live an extremely simple life and crime is almost unknown. They have intermarried amongst themselves for, as it is put, "countless" generations. In 1864 M. Voisin, interested in the effects of consanguineous marriage, spent a month in personally examining the facts on the spot. Amongst the total population of the Commune, at that date 3,300, he found forty-six marriages that he counted as consanguineous. He made no attempt to tabulate the marriages of very distant cousins but states that the great majority of the marriages were of that kind, *i. e.*, he found but few married couples who were not related by blood in some degree.

COUSIN-MARRIAGES FERTILE

To begin with, the fertility of the forty-six marriages detailed as consanguineous was decidedly higher than the average fertility for the whole of France. Next, he failed to find amongst the entire population (3,300) a single case of any of the various diseases and defects that are always named as being supposed to result from consanguinity

of parentage, and he describes the people themselves as healthy, robust and intelligent. The death-rate of those who grew up was very low and many of them lived to a great age. The infant mortality, however, was very high, chiefly from acute diseases of the chest and throat and especially "croup." It is of course possible that amongst these young children who succumbed to acute infantile diseases there were some who would have shown inferiorities or defects had they lived; but even if we grant that, it is difficult to believe that not one of the survivors would have suffered in some corresponding way. Nor does it seem likely that the acute diseases of childhood would have selected a specially large proportion of those who might afterwards have shown degeneracies.

A very similar account was given in 1885 of the small fishing village of Staithes between Whitby and Saltburn. And quite a number of almost identical cases are upon record.

Of course plenty of examples are to be found where an excessive proportion of diseased and degenerate *are* found amongst the offspring of cousin-parents. But these prove no more than that if such degeneracies exist in the stock they may be transmitted.

That inbreeding, very much closer in degree and repeated far more often than anything in modern human society, does not necessarily lead to degeneracy but quite the contrary is shown by the history of modern breeds of domestic animals. For it is of course admitted, not only that the marvelous improvements effected during the last 150 years in the breeds of horses, oxen, sheep and pigs—to name only the more important kinds of live stock—have been reached by careful selection of the individuals possessing the characters desired; but that, as we are constantly told, the only way to secure and to fix such desirable characters is to carry out this crossing of near relations; *i. e.*, we are told that the desirable characters come as the result of crossing parents both of whom possess them in some degree. Doubtless the same parents sometimes also contain the rudiments of undesirable characters and degeneracies also, but such individuals will as far as possible not be used for breeding, and the production of the weaknesses they show will thus to a large extent be checked. It may therefore be asserted that the history of modern breeds of domesticated animals affords little, if any, support to the doctrine that marriages of blood-relations can produce qualities —good or bad—that are not represented at all in either parent.

CLOSE IN-BREEDING

There does, however, seem reason to believe that fertility is, or may be, diminished by *very* close in-breeding, repeated for several generations (Darwin, Animals and Plants under Domestication, II., 101, etc.); I mean, *e. g.*, by mating, say, brother (*a*) with sister (*b*), and subsequently the father (*a*) with their daughter (*d*), and again with her daughter (*e*) and so on or *vice versa* as to sex. It is further asserted that when such infertility has reached a dangerous degree it can often be counteracted, *i. e.*, the normal fertility of the race or species be restored, by crossing with a non-related stock; or what appears still more strange, by crossing with a very distantly related member of the same stock,— one derived from another branch of the same stem but perhaps reared under somewhat different conditions. We may perhaps take comfort from this and— whilst fully admitting that what is true for some of the lower animals may not always be true for man, especially in regard to the higher and distinctively human attributes,—conclude provisionally that if it should ever be shown that human cousin marriages were less prolific than others, this defect would most likely be neutralized by the next out-marriage.

Huth ("The Marriage of Near Kin," pp. 193-96), summing up the material then available (1887) as to the number of children born to parents who were blood-relations and to those that were unrelated, respectively, found that the consanguineous marriages appeared to be more fertile than the others; and although he thinks that, owing to uncon-

scious selection on the part of some of the authors whose data he quotes, the statistics are not entirely trustworthy, the conclusion is that consanguineous unions have certainly not proved to be less productive than others, and that the probabilities point to their being more so.

The only contribution I can make at the moment to this subject shows very little difference between the number of children born to parents who were, and were not, cousins respectively. The data relate to the chronic progressive eye-disease, Retinitis pigmentosa; the numbers are not nearly large enough for final conclusions, and the information on which they are based was sometimes unavoidably incomplete. But I give them for what they are worth. In ninety-three completed families of children (childships) the offspring of non-consanguineous parentage, containing cases of the disease just mentioned, there were 591 children, or 6.3 to each marriage (average). In forty-eight childships the offspring of consanguineous parentage (usually first cousinship) there were 259 children or an average of 5.5 to each marriage. The difference of fertility, such as it is, is against the cousin marriages, but as already stated we could not safely draw conclusions from such a small series, even if it were certain that consanguinity had been recorded in every instance where it had been present.

I think, therefore, we may conclude that marriages between cousins are as safe from the eugenic point of view as any other marriages, provided the parents and stock are sound.

The difficulty, of course, both for consanguineous and out-marriages is to decide upon this vital point; and as for obvious reasons the family history is more likely to be forthcoming for a pair of cousins than for an unrelated pair, we have here a part explanation of the aversion to cousin marriage met with in some families. This explanation will tell with special force if the disease or defect is relatively rare for then it will be more likely to occur, though in a latent form, in two cousins than in two strangers. But if the defect apprehended be a frequent one, *e. g.*, tuberculosis, the chances of the hereditary liability to it being present in both parents and intensified in their children may be much the same whether the parents were cousins or not.

It seems to me that since we as yet know next to nothing of how the various transmissible characters, good, bad or indifferent, are, or at least may be, linked together in inheritance; and that there are many other factors in marriage beyond those relating directly to race improvement or the reverse; it is best, in the present state of our information, not to discourage marriage between cousins unless there be a clear case; *e. g.*, inferiority or instability of a definite kind, or the history in the stock of such distinct diseases, or liabilities to them, as the eye disease, Retinitis pigmentosa, or deaf-mutism and others, more familiar to us, that could be named.

Pan-American Scientific Congress

The second Pan-American Scientific Congress will be held in Washington from December 27, 1915, to January 8, 1916. Eugenics has been alloted a place in the section for Anthropology, while plant-breeding and animal-breeding will come under the Section on Conservation of Natural Resources, Agriculture, Irrigation and Forestry. It is hoped that the principal genetists of Central and South America will be in attendance, and will describe the practical work in breeding which is being done in those countries. George M. Rommel, secretary of this Association, is chairman of the subcommittee dealing with conservation and agriculture.

GREEN LEAF IN CHERRY BLOSSOM

DAVID FAIRCHILD.

IT HAS long been known that the reproductive organs of a flower could, under certain circumstances, be replaced by leaves—either the ordinary stem-leaf or the flower leaf (petal). Double flowers are in most cases due to a replacement of stamens or pistils by petals, and are for this reason sterile. Examination of a carnation or almost any highly developed double flower will show that it must necessarily be sterile, since it altogether lacks the reproductive organs.

The appearance of an ordinary leaf in place of some part of the seed-producing apparatus is rarer, but an excellent example is shown in FIG. 7, a blossom from a Japanese flowering cherry (*Prunus pseudo-cerasus*) at my home near Chevy Chase, Maryland. The pistil is lacking, and its place is occupied by two well-formed green leaves (a) and (b), the teeth or serrations along the margins of the leaves being clearly visible. Such a phenomenon is technically known as phyllody.

The older botanists looked on such a change as a metamorphosis, believing that the pistil had actually been changed into a leaf. At present, it is more usual to regard it merely as a replacement, since this does not involve the assumption, formerly made without hesitation, that the reproductive organs are morphologically nothing but modified leaves, which might easily reappear through "reversion." The sporophylls or reproductive organs of the flower may be modified leaves, but it is equally possible that leaves are modified sporophylls; and until evidence is available from which the case can be proved one way or the other, it is safer not to assume that the sudden appearance of a little leaf in the center of the flower, as shown in the illustration, is a reversion of some organ to its ancestral type.

Even as to the evolutionary origin of the petals, we are not yet certain. A. P. de Candolle (1817) seems to have been the father of the idea which prevailed for nearly a century, that all the floral leaves are derived from sporophylls, the plant having found it presumably advantageous to modify some of its sporophylls in a conspicuous way, in order that it might attract the attention of insects and secure the pollination of the remaining sporophylls. Recently, however, Goebel and others have contended that the petals may in some cases be modified bracts or true leaves.

If we go back one step farther, we can disregard these slight difficulties and say broadly that a flower is merely a highly modified stem of the bud type. This will be recognized by anyone who examines a flower bud before it opens. The showy petals, which to the layman are the distinctive part of a flower, are in fact merely ornaments of comparatively late addition, from an evolutionary point of view, and not at all necessary to make a flower. From the morphological viewpoint the presence of the sporophylls, the organs which bear ovule and pollen grains, is the criterion recognized by most botanists. The origin of these sporophylls, the stamens and carpels, is obscure. They are very ancient structures, and although they are represented in lower plants by leaves bearing sporangia, or organs for the distribution of spores, it is possible, as was indicated above, that at a still earlier period leaves were the luxury and sporophylls of some kind the primary necessity of the plant.

The causes leading to such a replacement as that illustrated in the photograph are still almost wholly obscure. They are rather vaguely ascribed, in many cases, to an excess in nutrition, but there is reason to believe that in a large number of instances such a change is to be considered as originating in the germ-plasm. Evidently, a phenomenon of this sort is likely to complicate our idea of heredity in a very embarrassing way, and to cause us to hesitate before accepting too confidently any theory which will make heredity a simple matter of the shuffling of unalterable unit characters in a purely mechanical manner.

GREEN LEAF IN A CHERRY BLOSSOM

In this blossom of a Japanese flowering cherry (much enlarged) the pistil has been replaced by two green leaves (*a*, *b*). The pistil is the organ which is usually described as the female part of the flower; it includes an ovule, and some appliance for catching pollen grains and allowing them to fertilize the ovule. It is possible that it is, from an evolutionary point of view, a modified leaf: if so, such a phenomenon as is here shown would be a case of reversion. It is also possible that the leaf is a modified pistil. Photograph by Fairchild. (Fig. 7.)

PRACTICAL DOG BREEDING

A First Attempt To Apply the Modern Principles of Genetics to the Needs of Dog Fanciers.

REVIEW OF A BOOK BY WILLIAMS HAYNES

IT HAS long and deservedly been a matter of reproach to the science of genetics, that it has not succeeded in getting in sufficiently close touch with the practical, producing breeders of the country. Genetics is obviously one of the subjects, a knowledge of which would be of direct profit to almost everyone; yet the average man, even the average breeder, knows little of modern discoveries in heredity. The organizers of the American Genetic Association twelve years ago saw the need and attempted to meet it, believing that if there were some central body to collect and disseminate genetic information, plenty of individuals would be found to put it into further circulation. So far, this belief has hardly been justified, and the genetist must therefore welcome with particular warmth such a handbook[1] as the one which Williams Haynes, of New York, a breeder and judge of long experience, has prepared for fellow fanciers of the dog. The principal dissatisfaction likely to arise in the mind of a reader of it is that such handbooks are not available to devotees of every other kind of livestock.

DOG BREEDING NOT DIFFICULT.

Mr. Haynes has been remarkably successful in giving clear and simple expression to the ideas of genetics—translating them, as he says, into "dog talk" and usually illustrating his points with examples drawn from the kennel. While the book is thus specialized, as it should be, it yet deals with the fundamental principles of breeding so soundly that breeders of any kind of live stock would derive enjoyment and profit from reading it.

As is pointed out in the preface, dog breeders, like breeders of other kinds of pet stock, have lagged behind the breeders of stock for profit, and it is still not rare to find a dog breeder of note who will acknowledge that his system consists of "putting two good ones together and trusting to luck." Yet, "compared with other breeders, the dog fancier has an easy task. In the first place, he has less for which to breed. Secondly, dog histories and dog pedigrees have been for generations carefully recorded. Lastly, dogs have been bred toward approximately the same ideal for a considerable length of time." In spite of this, it is well known that dog breeding in the United States is in an unsatisfactory condition, and that fanciers are continually resorting to the importation of dogs from England or the continent. This condition could easily be remedied, Mr. Haynes thinks, if fanciers would study their breeds carefully and familiarize themselves with the value of the pedigree; and to emphasize the desirability of the latter end his handbook is largely devoted.

A chapter briefly recounting the facts of reproduction, from a biological viewpoint, is followed by one on variation, "the backbone of breeding." That with which the dog fancier is concerned is largely of a discontinuous nature, although it seems probable that some of the fancy points of highly artificial breeds appeared as discontinuous variations, or mutations. The screw tail of the English Bulldog is a case in point; it not only breeds true, but has been bred into the Boston Terrier and French Bulldog. The alleged production of variation through telegony and maternal impression is mentioned with proper

[1] Practical Dog Breeding, by Williams Haynes. Outing Handbooks, No. 30. Small 8vo, pp. 211, price 70 cents. Outing Publishing Company, 141 W. 36th Street, New York, 1915.

skepticism. As to the effect of climate, what Mr. Haynes says will be of general interest:

"The instances of deterioration in British breeds of dogs introduced into India have been often quoted from Darwin, but since he collected his information additional facts have been brought forward. A strong dog fancy has developed in India, with numerous shows under the jurisdiction of the Indian Kennel Club. Judging from descriptions and photographs, Indian breeders have been able to produce dogs that compare favorably with their direct importations from England, and today we hear little about the degeneration of dogs in the eastern country. Moreover, the success of the Airedale Terrier in the Philippines and throughout tropical America is further confirmation of the fact that climate does not have such a direct bearing on variation as was formerly supposed."

MENDELISM IN DOGS.

In his chapter of heredity, Mr. Haynes falls back largely on Galton, emphasizing particularly the law of regression. Mendelism is briefly described, with the comment that not enough experimental breeding has been done with dogs to throw much light on the unit characters present. The work of C. C. Little[2] makes it probable that the inheritance of coat color in pointers follows Mendelian rules, and can be bred for with confidence. "Dr. C. G. Darling believes eye coloring in Airedale Terriers is Mendelian, the light color being dominant. He acknowledges that he has not sufficient data to either prove or discredit this hypothesis, but, as an eye specialist and a terrier breeder, his opinion bears weight. If he is correct, it is probable that all eye color in dogs follows Mendelian inheritance." The same, as every one knows, holds true in Man, with the exception that here the dark pigment is dominant.

"It is also probable that the smooth and broken coats in Fox Terriers, a form of cross-breeding that is common, is Mendelian, the broken coat being in this case dominant. The red and black coloring in Chow Chows and self-colored spaniels is also probably according to Mendelian inheritance."

"In our conceptions of heredity," Mr. Haynes concludes, "we dog breeders have made two mistakes. These are natural ones, and it is some consolation to know that other breeders, and even trained biologists, have fallen into the same errors. In the first place, we have paid too much attention to the exceptional individual, the dog that is a 'stormer,' way above the average of his race. Secondly, and this sounds somewhat paradoxical, we have not paid enough attention to the individual points that go to make up the whole dog.

"In our almost fetish worship of the Champion of Record, we have been led astray in formulating any sound systems of breeding. We have overlooked the great average of the race and the drag that this average always exerts." And "although as breeders we are continually working for the development or effacement of certain points, we have overlooked the fact that these different characters behave differently in transmission. Some blend, others never do. Some are correlated, others quite independent."

SCIENTIFIC SELECTION.

These facts are the basis for the work of selection. The dog breeder is merely a spectator of variation and heredity. He can not control them directly; he must arrive at his goal by selecting from the material at hand. Mr. Haynes discusses selection under three heads.

(1) What is the true object of selection? "It is very evident that the only way the breeder can make any important, permanent headway is to bring the average of his own strain closer to the ideal expressed in the Standard than it is to the average of the race. In this way, and only in this way, can the drag of the race be lessened, and this drag is the breeders' worst enemy. Until he can overcome it, his breeding can only be partly successful. To overcome it, by raising the average of his own strain, is the true object of all selection."

[2] Journal of Heredity, V, 6, pp. 244–248, June, 1914.

Just what this drag of the race means to the breeder is expressed in mathematical form by Galton's Law of Ancestral Heredity, which is generally found to be substantially correct wherever large numbers are concerned, although it, like all other statistical generalizations, may be wholly misleading in individual cases. Galton's Law states the average contribution of each ancestor, all the way to infinity: in the following table only the first six generations are considered, the effective heritage contributed by each of these generations, and by each individual in the generation, being expressed in percents.:

Generation	Number of Ancestors	Influence of Generation	Influence of Individual
1	2	50.	25.
2	4	25.	6.25
3	8	12.5	1.56
4	16	6.25	0.39
5	32	3.125	0.10
6	64	1.5625	0.024

In other words, the individual gets only half his heritage from his parents, the rest from his more remote ancestors. The true object of selection, therefore, is to establish a strain in which the ancestors as far back as possible will conform to the desired type.

(2) Can selection accomplish this object? Theoretically yes, without any hesitation. "A somewhat involved mathematical proof has been worked out to show that after six generations of careful and continued selection a certain character will invariably breed true. No further selection for that point is necessary, provided no dogs which will deteriorate the inheritance for that point are introduced into the strain." A good pedigree for six generations is for most purposes as good as one for sixty.

"The breeder can expect that intelligent, continued selection will change type in any desired direction, and that new type will breed true after six generations of continued selection. He cannot, however, expect to accomplish any material reduction in the amount of variation. So far as the opportunity that variation always presents for further selection is concerned, the breeder will always have material available, but there are mechanical and physiological limits beyond which no amount of selection can ever be carried. However, in all probability, these limits have not been reached, except possibly in the size of the very large and very small breeds."

(3) What are the principles involved in rational selection? First and foremost, the breeder must know the points of the dog he is breeding. He must know the history of his breed. A knowledge of the famous dogs of the past will soon serve to locate prepotent strains, which have perhaps been produced by inbreeding, and which can be of great value. Study of pedigrees, then, is a matter of vital importance; and as a practical rule, the breeder must set before him an ideal and always breed toward it.

So much for the principles of dog breeding. In the second part of the book Mr. Haynes discusses practice rather than theory. What he says about inbreeding will be particularly interesting:

WHAT INBREEDING MEANS.

"The whole subject has been badly muddled by a loose use of the term inbreeding, and by very hazy notions on the part of every one concerned as to just how common true inbreeding is among dogs.

"Inbreeding means nothing more nor less than the crossing of the blood of one individual. There are only three possible ways in which this can be accomplished. (1) By breeding a sire to his own daughter. (2) By breeding

a dam to her own son. (3) By breeding together full brother and full sister. These, and only these, are true inbreeding." Any other consanguineous matings are to be called line-breeding.

As a fact, inbreeding is not common, it appears, among first-class dogs. An examination of records showed that "including both inbreeding and the primary cross of line-breeding only 7% of the Scottish terriers are closely bred, and but 13% of the Airedales." Mr. Haynes strongly indorses line-breeding, but holds that "continued inbreeding results in degeneration of both physical and mental powers."

As to breeding systems, whose name is Legion, Mr. Haynes reduces them all to six different basic systems, three of which "are no systems at all," and he takes occasion to warn his readers that successful breeding is not a matter of some mathematical or mechanical "system" but of knowledge and judgment. The systems he recognizes are:

(1) Trust to luck.

(2) Breed to the latest sensational winner. This he calls the "fashionable breeding system."

(3) The egotistical system—i. e., the one in which the fancier always breeds to his own dogs, "because it is cheaper, because it gives them greater opportunity as sires, or because it supplies the puppies with pedigrees that look as if he had established a strain of his own." These three systems are all actively bad.

(4) Inbreeding.

(5) Line-breeding.

(6) Outbreeding. Each one of these has its own place, but must not be considered as an infallible rule.

The effect of inbreeding is to magnify the heredity of a single individual. This is often highly desirable, and most breeds of live-stock have been built up by inbreeding. But as bad as well as good points are intensified, inbreeding is a two-edged sword which must be used with great care.

VALUE OF LINE-BREEDING.

"Judged by the results produced, however, line-breeding, although its results have been slower and are less sensational, has been even more effective. In our pedigree studies we saw[3] that line-breeding has, in the case of two typical terriers, produced more than five times as many champions as inbreeding."

"Line-breeding can be defined as the combination of the blood of a certain individual without the direct use of that same individual. It is fairly represented in the marriage of cousins in whose children the blood of the grand-parents is again combined."

"Straight out-breeding, the scrupulous avoidance of all close-breeding of any type, is a child of the super-fear of the noxious effects of continued close-breeding. From what has been said, it is plain that this is foolish and unprofitable. Moreover, from a practical point of view, it is almost impossible."

From these methods, Mr. Haynes "pieces together" a system that he feels confident in recommending to breeders. The breeder should learn all he can of the history of his variety and then he will draw up for himself a very definite ideal. His actual breeding operations will be directed toward the establishment of a strain that will as closely as possible approximate this ideal.

How can this be done? By transforming "the drag of the race" from an enemy to an ally, Mr. Haynes believes.

"Even a casual study of any breed will reveal the fact that certain points 'come good' in the majority of the dogs. Other points are commonly bad. If in the selection of the brood bitches of his kennels, a breeder gets two or three of sound average type, but excelling particularly in those points in which their breed, as a breed, is weak, he will have made the best possible start toward the establishment of that ideal strain. Naturally, these bitches should not only excel in these weak points of their breed, but should, so much as possible, be bred from stock strong in these same characters. Bred to dogs excelling in these same points, and better in others, the foundation of the strain is well laid.

[3]Journal of Heredity, V, 8, pp. 368-369, August, 1914.

"In every subsequent mating that takes place a breeder should always strive to hold every good point possessed by his bitch, and to add to them something extra from the stud dog. The dangerous pitfall that trips hundreds of thoughtful breeders is the attempt to balance points, good and bad, against each other. A bitch excelling in eyes, skull and ears but lamentably bad in foreface will be bred to a dog with capital foreface, but shocking in eyes, ears and skull. Or a bitch with speed and hunting sense, but lacking in bottom, will be mated to a solid dog with substance to spare, but little else to recommend him. As an example of glorious optimism such matings are splendid, but as breeding operations they are pathetic. The result is more than apt to be a spoiling of whatever good points were possessed by both parents, for these points were probably above the average of the race, and the principle of regression would tend to pull the avearge of the puppies back closer to the breed mean. Always hold then whatever good points we have, endeavoring in each successive mating to add to these other good points."

"Working on this basis, there are two things useful in narrowing the selection of the individual dogs in any particular mating. Always judge a dog as a breeding unit not by its own points, but on its ancestry and progeny."

"The elimination of all guess-work and the willingness to accept considerable length of time before success comes should be the first resolution made by a breeder. This means study, first, of the principles of genetics; next, of the breed with which one is dealing; and lastly, of the individuals employed in every mating. Working upon a foundation of excellence in the weak points of his breed and always retaining good points gained and adding others to these, the breeder, provided he judges his breeding stock by their puppies rather than by their own points, is sure to establish a strain upon which he can count for results. This, however, can not be done in a season. The breeder must possess those qualities we all admire in our dogs, patience, gameness and faithfulness."

Fruit Breeding in Alaska

There are two species of strawberry wild in Alaska, one in the coast region and one in the interior. Pollen from both of these has been used in hybridizing cultivated varieties of the strawberry, in order to induce hardiness. The crosses with the native plant of the coast region have been a conspicuous success. Nearly 4,000 of the hybrids thus produced have fruited and some hundreds of them are good enough to be retained for further testing.

The crosses with the native plant of the interior have been but few, and so far without noted improvement on the cultivated parent, except in matter of hardiness.

We have crossed the cultivated raspberry with pollen from the native salmon berry and produced many seedlings. The hybrids, however, are nearly all sterile; nothing of value has been produced, but we propose to continue crossing with other native species of the genus.

Attempts are now being made to cross native species of Ribes on cultivated varieties of *Ribes rumbrum* and *R. nigrum*. Some work is also being done with gooseberries.

We have for several years attempted to cross the native crabapple on cultivated varieties of the apple, but for various reasons little seed has been produced. The work is continued, however. It is almost certain that if apples are ever to be grown successfully in Alaska, the trees must contain the blood of this native crabapple. Imported cultivated varieties, even the hardiest and earliest of them, can be grown only with partial success.

C. C. Georgeson.
Special Agent in Charge of Alaska Investigations, U. S. Dept. of Agriculture.

DETERMINATION OF SEX

Experimental Biology Making Progress in the Solution of Fundamental Problem—Sex-control in Men Now Impossible but May Some Day Be Realized.

Review of a Book by Leonard Doncaster
Fellow of King's College, Cambridge, England

HARDLY any problem in biology has aroused such interest as that of sex, and the amount written on it is staggering—the number of hypotheses put forward to explain the determination of sex is said to be not far from 500. As long as the problem was attacked only by wordy speculation, based on philosophical theories or observation of uncontrolled phenomena, little progress could be made; but the experimental school of biology attacked it in a more direct way, and is beginning, its adherents think, to see light. "The last few years have seen a considerable advance, and we now know at least something of the causes which lead to the production of one or the other sex, although of the manner in which these causes act our ignorance is still profound."

The experiments of the biologists are scattered through a voluminous periodical literature, and it is therefore well worth while to have them brought together and digested by a man who is himself a leader in the work. Dr. Leonard Doncaster, superintendent of the museum of zoology at Cambridge University, has undertaken the task, and his book,[1] "The Determination of Sex," is not only up-to-date and critical, but written in a clear and pleasing style, which makes it a welcome addition to genetic literature. At a time when biologists tend to express their ideas in mathematical symbols, there is need for leaders of the science who are able to expose their subjects in literary English; and Dr. Doncaster proves himself to be such a one.

His review is also marked by an unusually conservative attitude. "The study of sex has not yet reached a stage at which it is possible to give an account of the established facts, and of generally accepted inferences from them, which shall be even comparatively free from controversial matter," he remarks in his preface. "The subject has been approached by many quite different lines, and these lines, although convergent, have as yet given no indisputable indication of the central point towards which they all tend." Nevertheless, some solid facts seem well established, and it may be of interest to review these in company with Dr. Doncaster. His book does not discuss sex-determination in plants, and a large part of his illustrative material is drawn from breeding experiments with insects—work to which he himself has for a number of years given a large part of his time.

THE PURPOSE OF SEX

In the first place, the author does not subscribe to any one of the theories which have been confidently put forward to explain the origin of sex—the reason why the existence of two sexes is an advantage to a species. "It is a remarkable thing," he observes, "that apart from the fundamental attributes of living matter—assimilation, irritability, growth, and so forth—no single character is so widely distributed as sex; it occurs in some form in every large group of plants and animals, from the highest to the lowest, and yet of its true nature and meaning we have hardly a suspicion. Other widely dis-

[1] The Determination of Sex, by L. Doncaster, Sc. D. Pp. xii+172, 8vo, 22 plates; glossary and bibliography. Cambridge (England), University Press; New York, G. P. Putnam's Sons; 1914. Price, $2 net.

tributed characters have obvious functions; of the real function of sex we know nothing, and in the rare cases where it seems to have disappeared, the organism thrives to all appearance just as well without it. And in many other cases, especially in plants, where sex is definitely present, it may apparently be almost or quite functionless, as, for example, in the considerable number of plants which are habitually grown from grafts or cuttings, and in which fertile seeds are never set. It is of course impossible to say with confidence that such 'asexual' reproduction can go on quite indefinitely, but the evidence formerly adduced that continued vegetative reproduction leads to degeneration has been shown to be of doubtful validity. Sex, therefore, although it is almost universally found, cannot be said with certainty to be a necessary attribute of living things, and its real nature remains an apparently impenetrable mystery."

To understand the efforts made to solve the problem, it is necessary to have a clear appreciation of what sex is, and of the mechanism of sexual reproduction. We speak of certain kinds of animals and plants as female, and of other kinds as male: "The fundamental thing about the female sex is that female individuals produce bodies known as egg-cells or ova, which after uniting with a cell of a different character derived from the male, develop into new individuals." This description fits equally an animal or a plant. "Superficially, egg-cells vary greatly in appearance; they may be relatively large, owing to the inclusion of nourishing substance or yolk for the developing embryo, or they may be microscopic, as they generally are when no yolk is present. They may have a special protective covering, or may be naked, but apart from these differences, which are so to speak accidental, they are always characterized, in the most various animals and plants, by consisting of a mass of relatively unmodified protoplasm[2] containing a single nucleus.

"As the distinguishing character of the female is the production of eggs or ova, so that of the male is the production of male germ-cells, which, however, vary greatly in different cases. They are characterized by the fact that their function is to reach an ovum and unite with it in the process of fertilization, as will be described in more detail below. In nearly all animals and in many of the lower plants, the male germ-cells are for this purpose endowed with the power of independent locomotion; in animals they are called spermatozoa (in the singular spermatozoon, sometimes abbreviated to sperm) and in the lower plants spermatozoids. In the flowering plants the male germ-cells are enclosed in the pollen grains which are produced by the stamens of the flower; the pollen-grains have no power of independent movement, but are carried to the neighborhood of the egg-cell in the female flower, or part of the flower, either by wind or by insects, and thence grow out a tube which penetrates to the egg-cell and carries the male germ-cell into contact with it. Although, therefore, there are great differences between the male germ-cells of different organisms, they all agree in one essential feature, they are adapted for reaching in some way the more stationary egg-cell, they unite with it in the process of fertilization, and the *zygote* so produced proceeds to develop into a new individual. In animals, in which the spermatozoa have the power of independent movement in a fluid, these are commonly more or less tadpole-shaped, consisting chiefly of a 'head,' which contains little else beside the nucleus of the cell from which they have been derived, and a vibratile protoplasmic tail by the motion of which they travel through the fluid in search of the egg-cell.

"The essential feature of the process of fertilization is the union of the two nuclei contained respectively in the egg-cell and the head of the spermatozoon. The nucleus is a portion of protoplasm enclosed in a thin membrane

[2] "Protoplasm is the name given to the substance which is the material basis of all living things. In chemical constitution it resembles white-of-egg, and consists of very complex compounds of carbon, hydrogen, oxygen and nitrogen, with a smaller amount of sulphur, phosphorus and other mineral elements."

and differing from ordinary protoplasm in containing a quantity of a substance called *chromatin*, so called because it takes up stains (Greek, *chroma*) more readily than other parts of the cell. In its ordinary condition the chromatin is scattered in fine granules on protoplasmic threads enclosed in the nuclear membrane. We know that the nucleus is of fundamental importance to the life of the cell; metaphorically we may say that the nucleus is to the cell what the brain is to the body. When a spermatozoon meets an egg cell, it forces its way into it, until its head is embedded in the egg protoplasm; the tail is then dropped off, and the head, which consists almost entirely of a very concentrated nucleus, swells up until it reaches the size of the nucleus of the egg-cell. The two nuclei then slowly approach each other until they meet, when they fuse into a single zygote-nucleus, which immediately begins to divide in such a way that equal parts of both parental nuclei are contained in each half. The whole cell then divides in two, and the process is repeated until an embryo containing thousands of cells is produced. In every division the nucleus is divided in such a way that both paternal and maternal portions are accurately halved; from this it results that every cell of the offspring contains equal parts of the paternal and maternal nuclear substance (chromatin)." It is by the study of the details of this process of division that more light has been thrown on the problem of sex-determination, perhaps, than by any other method.

MIXTURE OF INHERITANCE

"In the process of fertilization we get almost our only definite indication of the ultimate nature and function of sex. We have seen that every part of every individual includes equal portions of nuclear matter descended from one and the other parent. The mechanism for producing this equal division is extremely beautiful and complex, and it is impossible to believe that it is not of fundamental importance. There is evidence that the nucleus, and particularly its chromatin, is especially concerned in the transmission of inherited characters, and the mechanism of nuclear division insures that, of this 'material basis of heredity,' the portion derived from each parent shall be equally distributed to every part of the body. One of the chief effects, then, of sexual reproduction, and perhaps its most important function, is the equal mingling in every individual of sets of inherited characters derived from two parents."

But such a result, whatever its advantages to the organism and the species may be, might also occur in the absence of two distinct sexes. "If all individuals produced similar germ-cells, and if these united with one another at random, we should still get fertilization and a similar recombination of characters, although there would be no division into males and females." Such a condition is, in fact, found in some of the simplest one-celled animals and plants, such as Protozoa, where two similar individuals fuse to form one. "In the higher, multicellular animals, such union of similar cells is never found, and even in the Protozoa it is usual that the two cells which conjugate (*i. e.*, unite in fertilization) should be dissimilar. One cause for this is not difficult to discover. The zygote formed by conjugation of two germ-cells has to grow up directly into a new individual, and if the function of fertilization referred to above is to be fulfilled, the germ-cells must come from different parents. If both cells were alike, it would be much more difficult for them to meet each other than if one is relatively large and stationary, the other small and active. Further, it is a great advantage to the embryo that it should be provided with some source of nourishment in its early stages. This is done in many cases by the storing up of food-material (yolk) in the egg, and it would clearly be impossible for two such yolk-laden eggs to seek each other out and unite. In a number of animals belonging to various groups, and also in the flowering plants, the embryo is supplied with nourishment direct from the mother, and this again would be impossible if both germ-cells

were alike. Hence it becomes clear that if once it is admitted that sexual reproduction is necessary or advantageous to the organism, the distinction of the two sexes, male and female, follows almost inevitably."

DIFFERENCES BETWEEN SEXES

Although this distinction between male and female as sperm-producer and egg-producer is the fundamental one for our present purpose, there are in general great differences of other kinds between the two sexes. The female in most species is relatively quiescent, passive, and devotes her time to storing up energy, for the benefit of her young; the male is "vigorous, restless and active, and characterized by the dissipation of energy rather than the storing of it." These physiological differences lead to the production of striking external differences, seen in the more conspicuous adornment of the males of most species, and the relatively inconspicuous appearance of most females; they even extend to mental characteristics of human beings, "since woman is said to be more receptive and conservative, while men show greater originality and are more inclined towards change."

In the adult animal, then, there is usually no difficulty in telling at a glance to which sex an individual belongs; "even in species in which the sexes are externally similar an examination of the mature reproductive organs will always reveal the sex with certainty." But in the embryo this is generally not the case: at an early, or sometimes even a late stage, it is impossible for the observer to say whether the individual is going to become a male or female. This puts sharply before us the question on which students have always been divided: whether at such an early stage the sex is already determined, or whether it is still to be determined by some environmental condition or conditions. In other words, is the sex determined when the egg and sperm cells unite, or is the embryo then and for some time afterward indifferent in character, and able to become either male or female, according to conditions? The latter theory has always been the more popular one, but the Mendelian school of genetists, and many of those who have studied the cell with the microscope, during recent years, incline to believe that the sex is fixed, once for all, when the ovum and spermatozoon come together. Each side has strong evidence and, as Dr. Doncaster points out, it seems very unlikely that both can be right; he therefore attempts to find some sort of a reconciliation between them.

PARTHENOGENESIS

First we must consider cases in which the sex is determined before the egg is laid. Such is the case among those insects, for example, where the reproduction is parthenogenetic—where the egg is never fertilized by a sperm. In such cases, it can often be predicted with certainty whether a given egg will result in a male or female. To quote a single instance, the plant-louse Phylloxera, which has so ravaged the vineyards of Europe, produces two kinds of eggs—large and small. Neither kind is fertilized by a male, but the former always produce females, the latter males. Among the Rotifers, and elsewhere, an egg which would have yielded a male if it had developed without fertilization, produces a female if it unites with a spermatozoon. The case of the honey-bee is well known: queens and workers are produced from fertilized, drones from unfertilized eggs. "All the eggs are as far as can be discovered originally alike; all undergo a similar maturation process, and the sex of the offspring seems to depend entirely on whether the egg-nucleus conjugates with a sperm-nucleus, or develops unfertilized." In this case, external conditions cannot determine sex. Among many similar cases, that of identical twins may be cited, as observed to good advantage in man and the armadillo. When twins, quadruplets, etc., are produced by the division of a single egg, rather than by the fertilization of several separate eggs, the individuals are always of the same sex, indicating that the sex must already be fixed immediately after the

fertilization of the egg, since division of the early embryo always gives rise to individuals of like sex.

The complicated phenomenon of sex-limited (or sex-linked) inheritance, which has been carefully investigated by many genetists during the last fifteen years, throws further light on the problem of sex-determination. Color-blindness in man is a common example: affected men married to normal women have, as a rule, only normal children; their sons show no tendency to transmit the affection, but some of their sisters and probably all of their daughters may transmit it to their male children. It is thus commonly said that the defect *appears* in men and *is transmitted by* women. It has been possible to determine exactly the proportion of affected individuals likely to appear in a given family; but in many cases these proportions are not found exactly, even in breeding experiments where large numbers are dealt with. The evidence from sex-limited inheritance can not be reviewed at length here, but it is of such a nature that to Dr. Doncaster "it seems impossible to doubt that sex-determining factors are borne by the ova and spermatozoa, and from the regularity of the observed results, that sex is in general fixed from the moment of fertilization and is not altered by events which may take place later." On the other hand, the occasional upsetting of the expected ratio indicates that other, obscure causes may be sometimes at work.

EVIDENCE FROM CELL-DIVISION

The next line of attack which Dr. Doncaster considers is one that has been pursued for only a few years, but which has proved particularly profitable—namely, the study, microscopically, of the germ-cells at the time of their divisions. The evidence here obtainable is based on the behavior of those much-talked-about bodies, the chromosomes.

"The nucleus of any cell in its ordinary condition is enclosed in a membrane, and consists of a more solid substance bathed in a fluid. Scattered evenly over the network are exceedingly minute granules of the substance known as chromatin which is especially characteristic of the nucleus as distinguished from the cell-protoplasm. When the nucleus is about to divide the chromatin gradually collects into masses, probably by the contraction and concentration of the threads of the network. These chromatin masses are known as *chromosomes*, and in general both their number and their relative sizes are constant not only in all the cells of any individual, but in all the individuals of any species Their number varies greatly in different species, so that the chromosome number may be regarded as a definite specific character." At each cell division, the chromosomes divide in halves, one half of each going into each one of the daughter cells. The number of chromosomes in the daughter cells is therefore the same as that in the mother cell, being in each case the number characteristic of the species. But if a sperm or egg-cell is preparing for conjugation, it goes through a so-called "maturation division" at which the number of chromosomes is reduced to one-half that characterizing the species. When it unites with a cell of the opposite sex, the full complement is thus restored. Obviously, if it were not for such a maturation division, the number of chromosomes in the fertilized egg-cell would be doubled at each generation. Without stopping to discuss the complex details of this cell division, or the action of the chromosomes in parthenogenesis, let us proceed at once to the most interesting part of the subject—the now famous case of the *X-chromosome*.

In some species, one sex has one less chromosome than the other, and this odd chromosome is known as the X-chromosome. The other sex, possessing an even number, is considered to have two X-chromosomes. In the white human race, for example, von Winiwarter found forty-seven chromosomes in the male, the forty-seventh being the X-chromosome, while the female seemed to have forty-eight, both the forty-seventh and forty-eighth

being assumed to be X-chromosomes.[3] Now the X-chromosome is conspicuous because of its unpaired condition, in contrast with all the rest of the chromosomes in the cell, and it can therefore be followed under the microscope, by anyone possessed of good eyes and unlimited patience. Its behavior has, in the minds of many, gone far to settle the question of sex-determination.

THE UNPAIRED CHROMOSOME

"It was known at the close of the last century," Dr. Doncaster reminds us, "that in insects of the order Orthoptera (grasshoppers, etc.) one chromosome behaved differently from the others in the development of the spermatozoa, and it was soon found that this chromosome was unpaired, and that in consequence half of the spermatozoa possessed it and half were without it. Its difference in behavior consists in its remaining as a compact body while the other chromosomes have the form of elongated loops at the stage at which the pairing of the ordinary chromosomes takes place, and it is this difference in behavior, in addition to its apparent connection with sex-determination, that justifies its designation by a special symbol as the X-chromosome. After the unpaired X-chromosome had been discovered in the males of certain Orthoptera and Hemiptera (plant-bugs), it was found that a pair of such chromosomes was present in the females of the same species. Since, therefore, in these forms, the female before the maturation divisions has two X-chromosomes and the male only one, it follows that after maturation all eggs possess an X-chromosome, while half the spermatoza have it and half do not. The eggs which are fertilized by spermatozoa containing X will then give rise to individuals which have two X-chromosomes, and will become females, while those fertilized by spermatozoa without X will develop into individuals with only one X, and these will be males."

If men of science could have stopped here, we might think that the problem of sex was a simple one. But it was soon found that although the condition above described existed in a number of species, conditions quite different were met with in other species. Both sexes have two X-chromosomes, in many species; but in many of these it was later found that one of the X-chromosomes in the male was smaller than, or different from, the other. It was accordingly named the Y-chromosome; and it was decided that, by the laws of chance, all fertilized eggs would have either the constitution XX or the constitution XY: the former would clearly become females and the latter males. But it has been pointed out above that the conditions in some species, particularly insects, show that there must be two kinds of eggs, some male-producing and the others female-producing. The "XY hypothesis," therefore, which would make the determination of sex wholly a function of the spermatozoon, acting under the law of probability, could not be supposed to have an absolutely universal application. Further investigation has brought many complications to light, so that sex is not now considered by most students to be universally and absolutely dependent on an X-chromosome, although there is a good deal of evidence to show that this unpaired or unequally-paired chromosome has an improtant rôle in the transmission of sex-limited characters.

IMPORTANCE OF CHROMOSOMES

The simplicity of the "X-hypothesis" is so attractive that it still has many adherents, but "it cannot be regarded as proved. Many eminent biologists believe that the chromosome behavior is not the cause, but is, so to speak, a symptom of sex, and that the cause of sex-determination lies deeper. No one believes that the presence of horns is the cause of a Red Deer being a stag instead of a hind; horns are a regular accompaniment of maleness in most deer, but are certainly not its cause. So it may be maintained that an egg

[3] In the negro race, Guyer's observations show a double X-chromosome in the male, with a total of twenty-two chromosomes. The count of large numbers of such small and elusive bodies is extraordinarily difficult, and results are not to be accepted too confidently.

or a spermatozoon may have one chromosome more or less because it has in it the power of developing into one or the other sex, rather than that the chromosome is the cause of sex. In any case, it is highly probable that sex is not determined simply and immediately by the presence or absence of a chromosome. Even if the chromosome behavior is a necessary link in the chain of causes leading to sex-determination, as seems to the writer probable, it is not the immediate or the only cause of sex."

If the determination of sex were due to such a simple cause as the law of chance, the two sexes ought to be produced in equal numbers, unless disturbing causes interfere. Everyone knows that in many animals, at least, the sex-ratio is approximately 1:1, as this hypothesis demands; but when the statistics are large enough, it is in general found that the excess of males is greater than the hypothesis in its simplest form calls for. Worse, the sex-ratio seems to fluctuate according to a variety of conditions.

"For 100 females born, it has been found that in man the ratio of males averages between 103 and 107, in the rat about 105, in the horse ninety-eight, in the dog about 118, rising in some breeds to over 140, while some animals have an even greater divergence from equality." The ratio is still more upset in man when still-births are counted, for a large part of early births and abortions are those of males, who apparently have a lower vitality than females at that stage of life. Evidently, then, the proportion of young of the two sexes produced is not equal, as the chromosome hypothesis seems to demand.

It has not been difficult, however, to find hypotheses to explain this. Two, at least, can be supported by some facts: "If it is assumed that the spermatozoon determines sex, the male-producing spermatozoa may perhaps be somewhat more active, or for some other reason, such as slightly smaller size, more successful in entering the egg; if, on the other hand, the egg has some share in sex-determination, there may be a tendency for the polar divisions to occur rather more often in such a way as to produce eggs of one sex rather than the other. Because, therefore, the sexes are not exactly equal in number the hypothesis of sex-determination by the germ-cells which unite to form the fertilized egg is not disproved. What is required is to investigate the causes which have been found by observation to influence the sex-ratio, and to relate them, if possible, with chromosome behavior."

EXTERNAL INFLUENCES

Such influences are to be found in temperature, nutrition, age of one or both of the parents, moisture content of the germ-cells, age of germ-cells at time of fertilization, hybridity, etc. The experiments and observations on the influence of these various factors are numerous, and most of them treacherous. In many cases they can be shown to have no effect on the sex-determination ratio, but merely to produce a differential mortality in the sexes. In other cases, the determination of sex does seem to Dr. Doncaster really to have been influenced. "On the whole, therefore, the study of the sex-ratio, while not leading to any positive conclusion with regard to sex-determination, makes it necessary to reconsider the simple hypothesis of final determination by one or other of two kinds of germ-cells, to which the facts of sex-limited inheritance and of chromosome behavior seem naturally to lead."

Lack of space prevents a review of the interesting chapters on secondary sexual characters, hermaphroditism and gynandromorphism. Dr. Doncaster's general conclusions must be considered at some length, even though the reader of this review has not been given in many cases the evidence on which they are based.

"Beginning with the question of the stage at which sex is determined, it was shown that in some cases it appears to be determined already in the unfertilized egg, in other cases to depend on the spermatozoon and to be fixed at fertilization, and in other cases again to be capable of modification

during the embryonic development or even at a later stage.

"Evidence for determination by the egg apart from fertilization was drawn (1) from the facts of parthenogenesis, (2) from sex-limited transmission by the female, and (3) from cases in which two kinds of fertilizable eggs are produced, which differ from each other in their chromosomes. In all these cases it is certain that, normally at least, male-determining and female-determining eggs are produced, and that if the kind of egg is known, the sex can be predicted without reference to the spermatozoon.

"Similarly, evidence for sex-determination by the spermatozoon is provided (1) by the cases in which unfertilized eggs yield males, fertilized eggs females, as in the bee; (2) by sex-limited transmission by the male, and (3) by the existence of two kinds of spermatozoa differing in respect of their chromosomes. In each of these three groups the evidence for sex-determination is exactly comparable with the similar determination by the egg in the previous class."

A SIMPLE HYPOTHESIS

If this were the extent of our knowledge, we would have fairly clear sailing. "Sex might be regarded as depending on the presence of a greater or less amount of some 'sex-determining substance' present in the chromosomes, or more correctly, on the physiological condition arising from the interaction of this substance with the substance of the cells. The presence of an additional 'dose' of this substance in a cell otherwise similar would alter its metabolism (*i. e.*, general physiological condition), and since all cells of the body would contain the extra dose, the whole physiology of the body would be affected, and the sex of the animal would be irrevocably determined."

"So far the problem is relatively simple: although nothing is known of the manner of action of the sex-determining factor supposed to reside in the sex-chromosomes, it can at least be said that in the cases mentioned it is inherited like any other Mendelian character (as was first suggested by Bateson and by Castle), and that individuals which receive it from both parents would be of one sex, those to which it is transmitted by one parent only, of the other sex.

"To this scheme, so attractive in its comparative simplicity and its close accord with the facts on which it is based, there are opposed a series of observations, usually derived from special cases and differing widely in kind among themselves, any one of which might perhaps be regarded as due to error or to chance, but which, when taken together, make a rather formidable obstacle to the acceptance of the hypothesis. They may be grouped under two heads, including (1) evidence that the egg may influence the sex in cases in which observations on chromosomes indicate that the sex should be determined by the spermatozoon; and (2) evidence that the sex may be modified after fertilization by influences acting on the embryo or even later in life."

These various objections are of such weight, in Dr. Doncaster's mind, as to make him feel certain "that sex-determination does not depend on an unmodifiable unit, but rather on the reciprocal action between an inherited factor and its surroundings." In the absence of disturbing factors, sex will indeed be determined by the chromosomes; and "if the difference between the chromosomes of the male and female is considerable, it will outweigh any other influences which might tend to affect the general result." If the difference is not great, the chromosomes can absolutely determine the sex only under favorable conditions; if other agencies intervene "it becomes possible for an egg which would otherwise have been female to develop into a male."

SEX-DETERMINATION IN MAN

Finally, a few words on the ever-interesting subject of sex-determination in man. From what has been said, it will be fairly obvious that we are not now in a position even to predict the sex of any child, much less to control it. But the possibility of eventual control

does not seem to Dr. Doncaster to be absolutely lacking. Certainly none of the means so far suggested, some of which have attained considerable notoriety, has any scientific standing, but this does not prove that we may not some time know more than we do now.

On the basis of Dr. Doncaster's hypothesis, it is obvious that control of sex might be possible in one of two ways: either by seeing that the child received the proper chromosomes at conception, or by finding some influence which would act on the embryo after conception so as to modify the determination of the chromosomes, if it were not what was desired. It is hardly possible to conceive of a way in which sex might be controlled by the first means, and a solution is therefore probably to be sought along the second line suggested.

While the male in the human species carries the X-chromosome, and therefore should determine the sex of the offspring, there is some evidence to indicate that the egg-cell also has an influence in determining the sex. So far, attempts to take advantage of this—*e. g.*, by special diet for the mother—have met with no success. The idea that the right ovary produces male eggs and the left one female-producing eggs also rests on a very slender foundation. When the huge mass of evidence available is carefully criticized, it becomes evident that at present we have absolutely no knowledge as to how any condition can so affect the mother as to determine the sex of her offspring; nevertheless in the light of Dr. Doncaster's hypothesis "it would follow that the search for means of influencing the sex of the offspring through the mother is not of necessity doomed to failure." It cannot be too strongly emphasized that at present there is no means known to science of controlling sex in the human species, but it seems to the author still reasonable "to retain an open mind and to regard the control of sex in man as an achievement not entirely impossible of realization."

Bud Selection in Apples

One of the important projects in hand at the Illinois agricultural experiment station concerns bud selection with apples. C. J. Crandall writes:

"Under this project the effort is being made to ascertain whether there are differences in value between buds taken from different portions of trees for purposes of propagation. Buds were selected for testing this in three different ways: first, on the basis of size; second, on the basis of the location on the tree; and third, on the basis of location on the shoot or branch. All selected buds were measured and described and then grafted on ordinary apple seedlings. The trees grown from these buds have been planted in orchard form, and there are now living 1,395 trees. Annual growth notes are being kept up on all trees and it is proposed to grow them to fruiting age before attempting to report on their behavior. I can only say at the present stage of the project that there appear to be some slight differences in favor of buds of large size, and in favor of terminal as contrasted with lateral buds."

Hardy Peaches for Missouri

Hardy peaches are being bred at the Missouri experiment station by crosses between large fruited, purple twigged sorts including Elberta, Champion, Carman, and the green twig sorts represented by Rise's Seedling and Snow. The work with peaches has shown them to be self-fertile; therefore growers who plant only one variety need not fear that they will not get a crop, although such planting with apples, pears and many other fruits, largely self-sterile, would be disastrous.

DEVELOPMENT OF A CHERRY

DEVELOPMENT of a fruit from a flower is a process the details of which vary widely in different species of plants, but of which the general outlines are fairly constant. In general, it may be said that the internal changes are very complicated but the external changes quite simple. The process can be easily followed in the accompanying illustrations, made from Japanese flower-cherries (*Prunus pseudo-cerasus*) and Japanese apricots (*Prunus mumme*) and considerably enlarged.

Starting with the flower, as shown in Figure 8, we notice first of all the beautiful pink petals. These represent the expenditure of an immense amount of energy on the part of the tree, and yet have no direct connection with the production of seeds—which may be said to be the tree's main purpose in life. When the ground below the tree is wholly carpeted with fallen petals, it may look as if the amount of energy thus used was wasted, but as a matter of fact the petals have served their purpose, and nearly every one knows that their purpose is a very useful one—that of attracting insects to the flowers, and thus securing cross-pollination of the blossoms, in order that two lines of ancestry may be united in the seed, and the resulting plant thus benefit from the traits of two parents. After the petals have fulfilled their end in attracting bees to the flower, they are of no further use to the tree, and are dropped.

The other conspicuous parts of the flower are the stamens or pollen-bearing organs, and the style, an organ designed to catch pollen carried either by wind or insects and transmit it to the ovule lying in the ovary below. It is not necessary here to follow out the details of this process of pollination—most readers understand how the pollen grain sends a long tube into the style and down to the ovary, and how the cell-nuclei of the pollen grain slip down this tube and unite with the ovule. There are then two pairs of cell-nuclei; one pair unites to form the embryo, and the other to form what is known as the endosperm—the starchy material surrounding the actual germ.

This union of the male and female cells—what the geneticists call zygosis—not only starts a complicated series of cell divisions in the ovule, leading to the production of the seed, but also stimulates the remaining parts of the flower to renewed growth. The stamens, whose function is finished after they have shed their pollen, wither and drop off in time. The style has also finished its work after it has furnished a route for pollen grains to reach the ovule, and it accordingly begins to wither; but as it is firmly attached, being in reality a modified prolongation of the end of the stem, it remains in place for a long while, frequently until the fruit has reached considerable size, as shown in the left of Figure 9. Finally, however, with the increasing size of the fruit, a layer of abscission cells is formed at the base of the style, all its nutrition is cut off, and the wind some day blows it away.

We have thus disposed of all the parts of the flower—petals, stamens and style—which were most conspicuous when it first appeared. Meantime, a part that was then apparently of little importance has developed remarkably. This is the ovary, which is from a historical point of view a thickening of the stem to act as a receptacle for the ovule—which, when fecundated, becomes the seed. As the seed develops, so does the ovary enclosing it. The changes here are principally chemical in nature, and not yet wholly understood. The tissues of the ovary swell up and become distended and succulent. Part of the starch is changed into sugar; considerable quantities of acid are formed, coloring matter is deposited all through the tissues, and finally, aromatic substances are created. This by no means catalogues all of the complex chemical changes, but it suggests

JAPANESE APRICOT BLOSSOMS

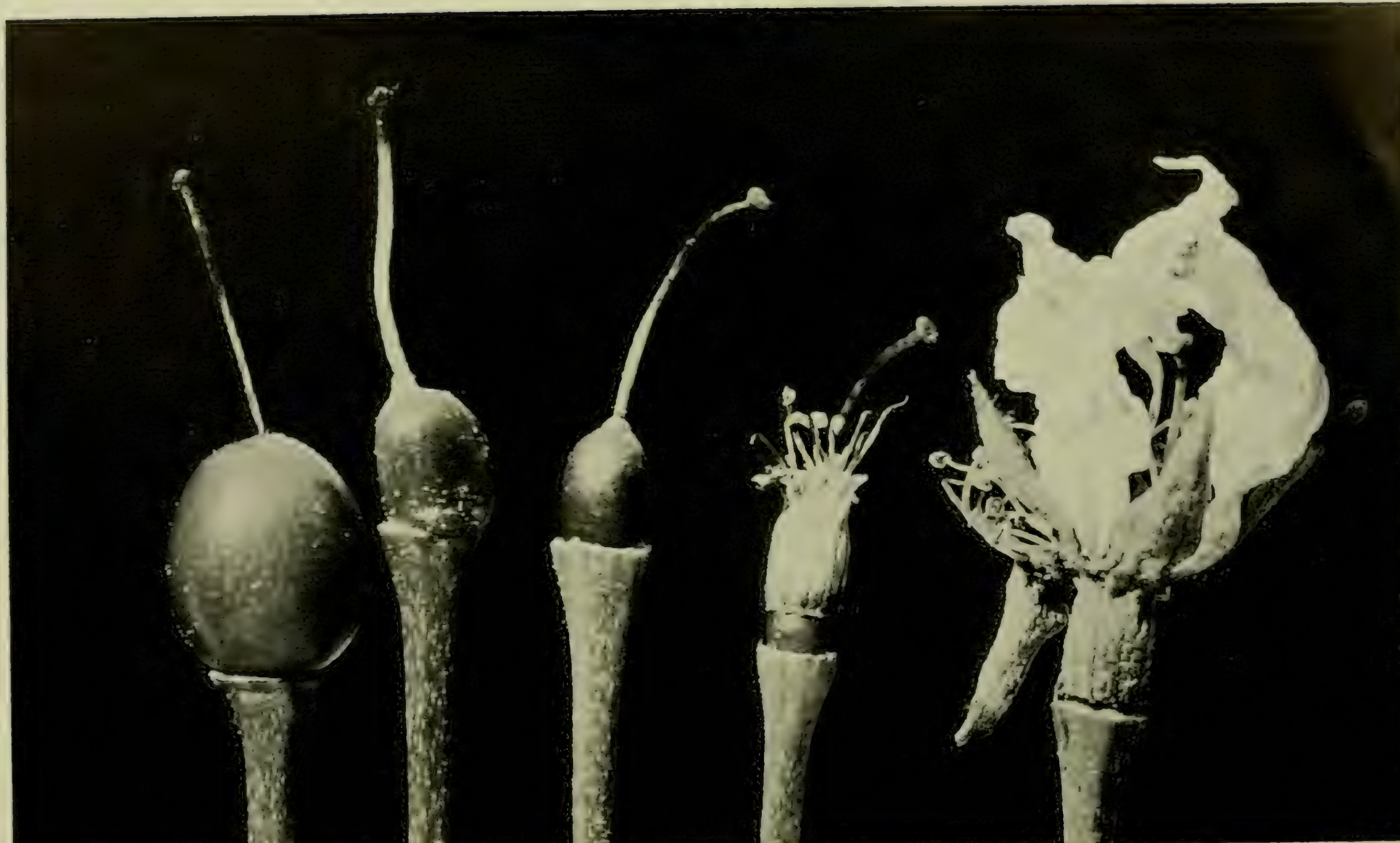
The conspicuous parts of the blossoms—petals and stamens—have no direct part in the formation of the fruit that is eaten, the function of the stamens being to furnish pollen, and that of the petals to advertise the existence of nectar, and attract bees who will distribute the pollen. Photograph by Fairchild. (Fig. 8.)

the most important ones. By the time the seed is fully mature and capable of gernimation when placed in a suitable environment, the ovary surrounding it has become the bulky structure which we know as the cherry.

Presumably the advantage to the tree in thus surrounding its hard seed with a succulent mass of flesh is that birds are led to eat it, and thus carry it to considerable distances. The seed coat is hard enough so that it passes through the intestinal tract of the bird without damage, and is finally excreted to lodge in some new locality and take root. The devices which Nature has developed for seed dispersal are varied, and some of them are, to man, of a disagreeable character. It is, to say the least, fortunate that some of them on the other hand are of such an agreeable character as our edible fruits.

Mendelism in Melons

Mendelian inheritance in melons has been worked out to some extent at the New Hampshire agricultural experiment station, through crosses of muskmelons with canteloupes. In the hybrid generation blending was found to be the rule, but the following generation revealed the segregation of six pairs of contrasted characters, or allelomorphs. Advantage can be taken of these results in scientific breeding of melons.



DEVELOPMENT OF A CHERRY

First, as shown on the right, the petals wither and fall, then the stamens and calyx likewise disappear. The style frequently adheres until the fruit has reached a considerable size. The details of the development of the fruit are described in the text. Photograph by Fairchild. (Fig. 9.)

PUTTING OVER EUGENICS

Making It a Living Force Depends on Sound Application of Psychology and Sociology—Camp Fire Girls an Organization Which Will Create Eugenic Ideals in Women in an Indirect but Effective Way

A. E. Hamilton.

Extension Department, Eugenics Record Office, Spring Harbor, Long Island, N. Y.

ONE of the finest women, physically, mentally, spiritually, that I have been honored to meet in my lecture travels told me that she and her sisters had refrained from marriage because her family tree showed branches withered by tuberculosis.

One of the brainest and brawniest young men I have ever known told me recently that the process of trying to rationalize his emotions and bring them into line with his intellectual content regarding fitness for marriage had led him to leave the side of the woman who would have made a splendid wife had they married, and betake himself to the solitary ways of scientific research.

One of the most sympathetic and child-loving men who has crossed my path writes of breaking an engagement on the score of finding doubtfully dysgenic influences in the family of his sweetheart, of falling in love with another admirable young woman and then tearing himself out again because of something he deemed not quite fitting in her hereditary constitution, and of finding another girl who seemed quite eugenically built, but who turned him down gently but flatly when he suggested that they be married for the sake of wellbornness in children.

And I might go on recording more of this sicklying o'er with the pale cast of bluegenic thought the young minds of potential parents, which seems to me almost the net result of many of the well-intended but myopic endeavors hitherto made to put over Galton's idea to the coming generation. Perhaps it is time for those of us who have the welfare of Eugenics at heart to ask ourselves what there is in a monograph on albinism, a study of the inheritance of idiocy, or a lecture on the declining birth-rate in college women or American men of science, to promote a desire on the part of our fittest young people for marriage and parenthood—for if that be not the keynote of Eugenics, then I sadly misconstrue the meaning of the word.

To which it may be answered that all our normal young folks desire marriage and parenthood—whereupon the question becomes; Do they desire it enough to overcome the obstacles, psychological, social and economic, that are thrust in their way because the conscious attention of those who should be educators and leaders has not been turned on these problems sufficiently to make a dent in them? Marriage and parenthood must ever remain matters of desire, and the work before the true promoter of Eugenics is that of social engineering which will make for the realization of desire in the wholesomest and quickest way. The man whose genius has given us the first self-supporting social institution designed for the most genuine race-betterment puts the challenge thus, "Can you develop the geniuses who will parallel in the social world what our inventors have done in the world of steam and electricity? Can you then create social self-supporting institutions that shall take these social inventions and so put the power of organization, publicity and finance behind them that they shall be as wide spread as the telephone, the movies or the telegraph?" In the organization of the Camp Fire Girls, the brain child of Doctor and Mrs. Luther Halsey Gulick, we have the pioneer type of such self-reliant and self-supporting institutions as will doubtless spring up

THE CAMP-FIRE CIRCLE

As far as is possible, Camp Fire girls are trained to act as hostesses in their communities. On such occasions as the one here pictured, they learn to seek the best side of the character of each individual, and to show that side to the individual and to others. What this may mean to the Eugenics movement is pointed out by Mr. Hamilton in the text. Photograph by Mrs. Luther H. Gulick. (Fig. 10.)

DEVELOPING THE BODY

Water sports and other carefully chosen forms of recreation are, in connection with the other Camp Fire activities, developing a spirit of physical and mental freedom in girls that will affect for good the parenthood of the next generation. Photograph by Mrs. Luther H. Gulick. (Fig. 11.)

to meet the demands of our new day. That here we have a splendid instrument for the promotion of true Eugenic ideals is sure if the words of its founder are made good, and from my own first-hand observations I should say that already they are being splendidly realized:

IDEAL OF THE FOUNDERS.

"Camp Fire Girls undertake in so far as they are able to act as Hostesses for their communities. The word Hostess brings to mind not so much one who is correct in matters of social usage as a woman who understands, who has insight, sympathy and tact. She often enables people to do what they never knew they had it in them to do. She reveals people even more to themselves than she helps them reveal themselves to others. She draws out each one's abilities by her power of intelligent appreciation. To her the arts of entertaining are those which bring people together, which reveal people to each other, which develop the social nature. To amuse is not her object, but to so treat her guests that the best in each is developed and fed by the best in everyone else. This is social genius. Camp Fire Girls aim to discover, develop and use social genius just as previous generations have discovered and used scientific genius. Into this work is being thrown an army of picked girls under the guidance of the ablest women. As they grow in power of team work, preserving the devotion and vision of youth, gaining

GIRLS MUST BE PHYSICALLY FIT

The Camp Fire is intended to educate girls in the true sense—that is, to give as full opportunity as possible to their valuable inborn characteristics to get expression. Physical fitness is one that, in the interests of the race, is naturally insisted upon. Photograph by Mrs. Luther H. Gulick. (Fig. 12.)

vision by experience, who shall say that they will not do for the affections as brilliantly as the previous generation has done for the industries. Both of these had their origin in the home but have grown beyond its confines."

"Camp Fire Girls is an organization of girls and women to develop the home spirit and make it dominate the entire community. Hence, the ranks should be recruited from those who have ability to do and to help rather than from those who need help. It is an army of girls rather than a mission to them. Military training is good for the health, but an army cannot be built out of invalids, selected because they need the outdoor life and exercise of a soldier. The purpose of Camp Fire is to find the ablest girls and women and to give them a training in team work that will enable and incline them effectively to give woman's service to the community. Girls and guardians do become improved by Camp Fire work just as the soldier is benefited by the army drill, but self improvement is no more the object for the girls than it is for the soldier. The primary purpose is to develop ideals, to train leaders, to create custom and fashion, habit and want. As Camp Fire girls grow up into women, they will have the training, experience and affection to help organize and carry on all of the social relations of the community, including the care of those who primarily need help. There are many institutions

"CAMP FIRE IS AN ARMY, NOT A HOSPITAL."

The organization is not intended primarily as a training school for the unfortunate, but as a training school for those who by birth and in other respects are likely to be leaders. It aims to help the mass of the population indirectly rather than directly, by turning out women who will be able and willing to disseminate its ideals in their own communities. Photograph by Mrs. Luther H. Gulick. (Fig. 13.)

GAINING CONTROL OF SELF

Fitness for motherhood is a happy by-product of Camp Fire activities, which make for splendid physique and intelligent control of one's own body and mind, and of Nature as we find her. Photograph by Mrs. Luther H. Gulick. (Fig. 14.)

of the hospital type, devoted to the unfortunate, and a few—if any—are working on this task to which we have devoted ourselves—that of building up an army of splendid women, trained in team work, devoted to the spiritual ideals of the home, and united in giving service to the community."

On being asked how Camp Fire girls were instructed and trained for motherhood, the mother out of whose home-camp life the movement originally sprang replied that no particular training or instruction was given to girls that could be labelled "for motherhood." The concept motherhood will not shrink into a course of training or into a text book. It is to be lived, not defined or imparted. Camp Fire girls win honor beads by work in seven crafts—health craft, camp craft, nature lore, home craft, hand craft, business and patriotism. As each girl receives honors she progresses from rank to rank in her group and in the organization, so that each attainment of an honor represents the realization of a desire for definite accomplishment. If the home craft honors lure girls to do those things that inevitably make for the best in home building and tending, if health craft and camp craft and Nature lore bring strong bodies, tested nerves and a realization of the mystery and purpose of love in the world of living things, then a big part of training for motherhood is accomplished as a by-product. But the girls have not been striving to become good mothers according to rule. They have been "seeking beauty," (which is the first of the seven laws of the Camp Fire) in a multitude of wisely selected and elective activities, and all the rest will have been added unto them.

EMBODIMENT OF EUGENICS

So, too, Eugenics, though nowhere mentioned in the literature of Camp Fire, finds its embodiment in the learning by doing which is Camp Fire. "To know the names, homes and occupations of grand-parents" for the earning of an honor in Patriotism, takes a girl into the fascinating field of genealogy where a little observation will suggest the segregation of hereditary characters, physical and mental, in the family history and so open up the study

A TEST OF SELF-RELIANCE

Only those who have tried paddling a birch-bark canoe in rough water and wind can appreciate the kinds of qualities that this girl is developing. Photograph by Mrs. Luther H. Gulick (Fig. 15.)

of inheritance in a natural, positive and interesting way.

To "investigate the effects of ventilation and sanitation in stores and factories employing women," another elective requirement for a bead, might lead to inquiries concerning the transmission of acquired characters, the difference between immediate effects of environment on women and their children and the strictly racial modifications of circumstance and time. The "study of ten public institutions in her locality" can hardly fail to acquaint a girl with the purpose and content of the poor-house, jail, insane asylum or home for the feeble in mind, and such a study, amateur and superficial as it may be, will bite deeper into the mind than the reading of a shelf full of official reports later on. A patriotism paper on Immigration brings up the great issues of value in human stock and the right to enter our gates. Studied and written about in a spirit of interest in subject matter plus the desire for accomplishment and the relation of the part to the whole, the Jukes and Ishmaelites and gunmen who flood into our country through the leaks in our immigration laws become real and living, and who that knows the slightest of the psychology of adolescence will doubt that such an interest, so stimulated, will influence the vote to be cast on these questions a few years later?

"To be familiar with National History as it affects woman's welfare" has already led two Camp Fire girls of my own acquaintance, walking in entirely different spheres, to hit upon the idea of camp fire and scouting activities as small beginnings of what William James dreamed might prove a moral equivalent of war.

Thus "the study of agencies under social control that may improve or impair the racial qualities of future generations either physically or mentally" is begun quite unconsciously, and

carried far beyond the academic stage of reading, writing and discussion, into the play-practice by a coming generation that will better fit it for facing these big world problems than perhaps any generation has ever been fitted before.

From fifty to seventy thousand young girls absorbing the Camp Fire environment, and their numbers increasing at the rate of about 2,000 girls a month, actually means something for the future of the race. The hiking, canoeing, swimming, cooking, and all-round glorification of work which seemed to my young friends a possible "moral equivalent of war," is developing a spirit of physical and mental freedom that will doubtless result in a finer fitness for motherhood and a keener perception of what is wanted in fatherhood for the next generation. It will also be found to be working out a solution for many an economic problem that results from our extravagance in luxuries, which are more than compensated for in the happy recreations of the out-of-doors and the simplifying of customs of eating and all-round living that comes with an appreciation of a life close to the heart of nature, whose wayward children we still are, despite our carapace of over-civilization.

THE TORCH-BEARERS

The highest rank in Camp Fire is that of the torch-bearer, whose desire, expressed on receiving the honor, is:

> "The light that has been given to me
> I desire to pass undimmed to others."

And its biological and social significance is made plain to those who work for and win the rank. In such a spirit we may hope to find at least the beginning of a realization of Galton's hope that Eugenics might become a living part of our very religious conception of life; for surely, as Saleeby has aptly put it: "If we have transferred our hopes of heaven to earth, and from ourselves to our children, they are no less religious, 'and they that shall be of us shall build up the old waste places; for we shall raise up the foundations of many generations.' "

Nor need this be conscious or reasoned. Perhaps the less we say to our young people about Eugenics directly, the better. Surely the less they have to deal first-hand with the black-symboled pedigrees of neuroses and disease that constitutes the major part of our present crop of eugenic literature, the more wholesome will be their attitude toward their own relation to life and its multiplication. It is not so much seeds of fear concerning going wrong that we need to sow, as it is seeds of strong desire to go right and pass on undimmed the light that is given us in a spirit of hope that the best is yet to be, for heresy though it seem to say so in this journal, it is our social heredity that preserves the best the race has wrought out of space and time, and the unmodifiable germ-plasm is, after all, more a matter of concern to the microscopist and bio-chemist than it is to our harvest of boys and girls. The hope I see for putting over Eugenics to the masses who need it most lies in the new interpretation of the world's poetry and romance, the making of life now and here romantic and interesting and splendidly worth while, so that we shall strenuously desire to perpetuate it and enjoy the holy fruits of its perpetuation, and this will be done only when we do as has been suggested, turn the current of humanity's genius into social channels and evolve as magnificent engines for social righteousness as we have for the discovery and control of weakness, disease and death. That this can and will be done we may already read in the signs of the times, not the least of these our Scouts and Camp Fire.

The

Journal of Heredity

(Formerly the American Breeders' Magazine)

Vol. VI, No. 7 July, 1915

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The Journal of Heredity is published monthly by the American Genetic Association (formerly called the American Breeders' Association) for the benefit of its members. Canadian members who desire to receive it should send 25 cents a year, in addition to their regular membership dues of $2, because of additional postage on the magazine; foreign members pay 50 cents extra for the same reason. Subscription price to non-members, $2.00 a year, foreign postage extra; price of single copies, 25 cents.

Entered as second-class matter February 24, 1915, at the postoffice at Washington, D. C., under the act of August 24, 1912.

Date of issue of this number, June 25, 1915.

THE GEORGIA VELVET BEAN

Several cases of "mutation" which have been thoroughly investigated can be regarded as due to the loss of a single genetic factor. Among these cases the best known is the occurrence of the "false wild oat" in pure strains of oats, which was the subject of a masterly monograph by Nilsson-Ehle. It appears not improbable that the loss of a genetic factor may occur occasionally in almost any pure line of plants. Sometimes the results are of agricultural value.

The Florida velvet bean (*Stizolobium deeringianum*) has long been grown in Georgia as a soil improver and cattle food; usually from Florida seed, since it often fails to ripen seed farther north. Several farmers in Georgia, however, seem to have found an earlier strain in their fields, three years or more ago, and this strain is now extensively grown there. At the left, above, is a photograph of one plant of the Florida velvet bean, taken at Gainesville, Fla., on Sept. 19, 1914; all plants were similar and bore flowers and young pods. At the right is a photograph, taken on the same day, of one of three plants of the Georgia velvet bean, from seeds planted on the same day and in the same row as the Florida. The Georgia plants had dropped their leaves and ripened all their pods, which were dry and ready to pick. In time of appearance of the first flowers, they were as early as the Yokohama bean and nearly two months earlier than the Florida. From crosses between the Yokohama and the Florida, I conclude that the Florida has a factor for late flowering, H, which the Yokohama does not possess. Hence it may be supposed that the Georgia velvet arose from the Florida velvet by the "spontaneous" loss of the factor H. Since H is dominant, the early plants would appear only in the second generation.—John Belling, Agricultural Experiment Station, Gainesville, Florida. (Frontispiece.)

AN AZTEC NARCOTIC

(*Lophophora williamsii*).

So-called "Sacred Mushroom," or Teonanacatl, Still in Use by the Indians of Mexico and the United States, Producing Hallucinations of a Remarkable Nature, Is Identified with the Peyotl Zacatecensis, or Devil's Root of Ancient Mexico, and the "Mescal Button" of Texas.[1]

W. E. SAFFORD

Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

ACCOUNTS of many early travellers in America and missionaries to the Indians call attention to the veneration of the aborigines for various plants, showing that they attributed to all plants a spirit somewhat like that of animals or even of man himself. To certain plants special honors were paid; others were avoided with dread; while others, with no pronounced virtues or evil properties, were little noticed. An example is given by a Mexican writer of the homage paid to a certain tree cut down in order to form a bridge over a stream in Michoacan. The people of the village were called together by the governor and a religious service was held about a cross erected for the special ceremony, with candles burning before it and choristers assisting. A procession was formed which climbed the mountain, where the tree was growing. When it fell there came an aged Indian woman who, taking a few of its branches, laid them on the trunk where it had been cut, and consoling it with loving words begged that it might not feel humiliated or angry; for they had chosen it on account of its magnificent stature and great strength, and it was destined to span a mighty river, so that all the people of the land of Michoacan might cross over upon it. And before dragging it away they placed upon the place where it had fallen a piece of lighted candle, which had been left over from Holy Thursday; and they repeated in its honor a very solemn litany, sprinkling it with holy water and much pulque.[2] On the next day, having propitiated the spirit of the tree, they bore away the hewn beam to the bridge with much shouting and jubilation.[3]

The same author speaks of the veneration paid by the Mexicans to certain medicinal plants and to the narcotics *Ololiuhqui*, the sacred *Nanacatl*, the *Peyotl*, and the *Picietl* (tobacco), "to which they ascribe deity and with which they practice superstitions."

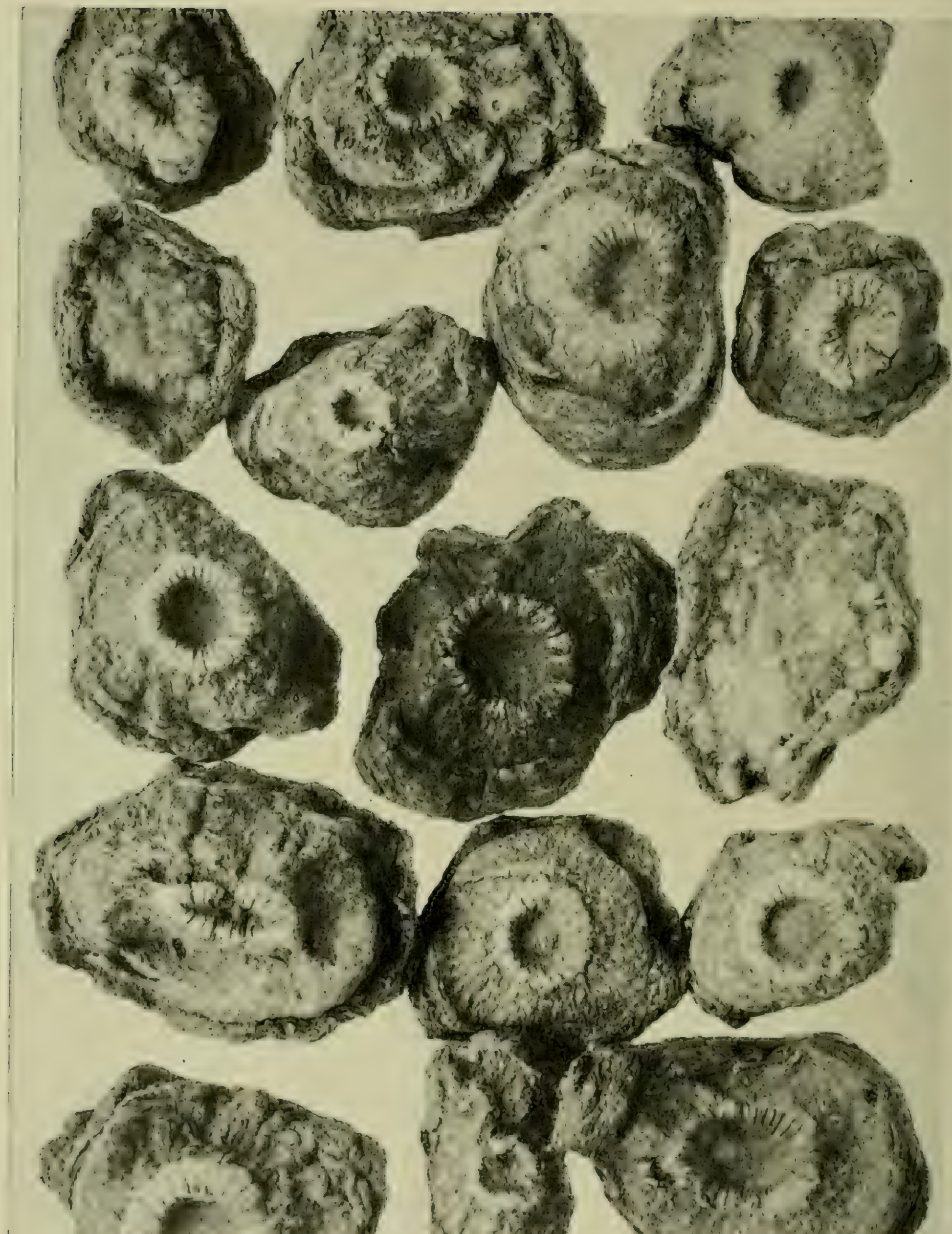
METHODS OF EXORCISM

The following example is among those given to show the method of exorcism employed by the Aztec *titzitls*, or herb doctors. In this case the spirit of the Ololiuhqui, is addressed. "Come now, come hither, *Green Woman*, behold the green heat and the brown heat; remove thou the flaming or scarlet heat, the yellow heat, or by this token I send thee to the seven caves. And, I command thee, put it not off till tomorrow or another day; for sooner or later thou wilt be compelled to do it. Who is the

[1] Based upon a paper entitled "Identification of the Teonanacatl, or 'Sacred Mushroom' of the Aztecs with the narcotic cactus, Lophophora, and an account of its ceremonial use in ancient and modern times," read by the author May 4, 1915, at a meeting of the Botanical Society of Washington. Published by authority of the Secretary of Agriculture.

[2] Fermented sap of the Century Plant (*Agave americana*), which also yields the strong distilled spirit called mescal.

[3] Jacinto de la Serna, "Manual de Ministros par el conocimiento de idolatrías y extirpacion de ellas." In Documentos inéditos para la Historia de España, vol. 104, p. 159-160.



THE AZTEC NARCOTIC CACTUS, TEONANACATL

"God's Flesh," or "Sacred Mushroom" of the Aztecs—discs cut from the crown of the cactus *Lophophora williamsii* and dried. Photograph of specimens received by the Bureau of Chemistry, U. S. Department of Agriculture from the Indian Office in 1914. Now widely used as a narcotic by Indians on United States Reservations.—Natural size. (Fig. 1.)

god—the so powerful and superior one—who can destroy the work of thy hands? I command it, I, the prince of enchantment." Others using the Hueinacaztli ("great-ear"), Mecaxochitl ("cord-flower"), and Coanenepilli ("serpent's tongue"), repeat the following: "Come hither, thou, the yellow and ardent red one; come and expel the green pain, the brown pain, which now wishes to take away the life of the son of the gods!" And with the herb Atlinan ("water-weed"), "I invoke thee, my mother, thou of the precious waters! Who is the god or who the so powerful one that wishes to destroy and burn my enchantment? Ea! Come thou, sister of the Green Woman, whom I am about to go and leave in the seven caves, where the green pain, the brown pain, will hide itself. Go and rub with thy hands the entrails of the bewitched one, so that thou mayst prove thy power and fall not into disgrace!"

EARLY HISTORY OF TEONANACATL

Bancroft, in referring to the narcotics used by the ancient Mexicans, mentions one, which was believed by the early Spaniards to be a fungus. In writing of their ceremonial feasts he says: "Among the ingredients used to make their drinks more intoxicating the most powerful was the *teonanacatl*, 'flesh of God,' a kind of mushroom which excited the passions and caused the partaker to see snakes and divers other visions."[4] This information was undoubtedly derived from accounts of the Spanish padres, one of whom, Bernardino Sahagun, writing before the year 1569, states that it was the Chichimeca Indians of the north who first discovered the properties and made use of these "evil mushrooms which intoxicate like wine."[5]

They were gathered in the territory now northern Mexico and southern Texas, preserved by drying, and carried southward. The inhabitants of the Valley of Mexico knew them only in their dry state. It is also very probable that the early writers who recorded their use had seen them only when dry and never knew them as living plants. Francisco Hernandez, the physician sent by Philip II in 1570 to study the resources of Mexico, or New Spain, describes them under the heading "*De nanacatl seu Fungorum genere.*" From the harmless white-mushrooms (*iztacnanacame*), red-mushrooms (*tlapalnanacame*), and yellow orbicular-mushrooms (*chimalnanacame*), used for food, he distinguished them as *teyhuinti*, which signifies "intoxicating."[6]

In this connection it is interesting to note that this Nahuatl word, *teyhuinti*, or *teyuinti*, (from yuinti, to be drunk) survives, in the form of *tejuino* or *tehuino* in the State of Jalisco, Mexico, and *tesuino* or *tizwin* in the south-western United States, as the name of certain intoxicating drinks, the principal of which is a kind of beer brewed from malted maize.

DETERMINATION OF THE DRUG

Three centuries of investigation have failed to reveal an endemic fungus used as an intoxicant in Mexico, nor is such a fungus mentioned either in works on mycology or pharmacography; yet the belief prevails even now that there is a narcotic Mexican fungus, and it is supported by Siméon in his monumental dictionary of the Nahuatl language, in which the following definitions occur:

"*Teonanacatl*, espèce de petit champignon qui a mauvais gout, enivre et cause des hallucinations; il est médicinal contre les fièvres et la goutte."[7]

"*Teyuinti*, qui enivre quelqu'un, enivrant; *teyuinti nanacatl*, champignon enivrant."[8]

In connection with his study of the economic plants of the Mexicans and the Indians of the south-western United

[4] Bancroft, H. H., Native Races, 2: 360. 1875.

[5] Sahagun, Bernardino (1499-1590). Hist. Nueva España (ed. Bustamente), vol. 3, p. 118.

[6] "Quoniam inebrare solent, Teyhuinti nomine nuncupati sunt, et e fulvo in fuscum vergant colorem, risum inopportunum concitent, imaginemque citra risum inebriantium possint exhibere." Hernandez, Francisco (1514-1578). Hist. Pl. Nov. Hisp. (ed. Rom.) 2:357. 1790.

[7] Siméon, Rémi, Dict. de la langue Nahuatl, p. 436, 1885.

[8] Op. cit. p. 412.

THE "DEVIL'S ROOT"

Peyotl Zacatecensis (*Lophophora williamsii*). "The root is of nearly medium size, sending forth no branches nor leaves above ground, but with a certain wooliness adhering to it. [On account of its magic properties] this root scarcely issues forth, but conceals itself in the ground, as though unwilling to harm those who may discover it and eat it."—Francisco Hernandez, 1576. Photograph natural size. (Fig. 2.)

States the writer has sought diligently for a fungus having the properties attributed to the *teonanacatl*. As this narcotic was used by various tribes of *Chichimecas*, and the Chichimecas inhabited the territory situated in what is now northern Mexico and the southwestern United States, it was natural to look for the plant in this region. No such fungus, however, was discovered, but in its place a narcotic plant having properties exactly like those attributed to the *teonanacatl* was encountered; moreover, one form of this plant, when prepared as a drug, resembles a dried mushroom so remarkably that at first glance it will even deceive a trained mycologist. It is discoid in form and apparently peltate when seen from below; but the upper surface bears tufts of silky hairs, and a close inspection reveals the fact that it is the crown of a small fleshy spineless cactus which has been cut off and dried. The cactus in question, *Lophophora williamsii*, when entire, resembles a carrot or radish rather than a mushroom, and when cut into longitudinal slices or irregular pieces, would never be mistaken for a fungus. For this reason the drug prepared in the latter form was not recognized in southern Mexico as the same as the discoid form, and it was called *peyotl* by the Aztecs, while the name *nanacatl* was applied to the latter.

IDENTITY WITH THE NARCOTIC PEYOTL

Sahagun, who described the drugs of the ancient Mexicans from specimens brought to him by Indian herb doctors, failed to recognize the identity of the *teonanacatl* and *peyotl* of the Chichimecas, although he attributes similar narcotic properties to each. The latter he describes as follows:

"There is another herb, like tunas[9] of the earth; it is called *peiotl;* it is white; it is produced in the north country; those who eat or drink it see visions either frightful or laughable; this intoxication lasts two or three days and then ceases; it is a common food of the Chichimecas, for it sustains them and gives them courage to fight and not feel fear nor hunger nor thirst; and they

[9] *Tuna*, the Spanish name for the fruit of the Opuntia, or prickly pear.

say that it protects them from all danger."[10]

The plant itself was described by Hernandez as follows, under the heading *De Peyotl Zacatecensi, seu radice molli et lanuginosa.*

"The root is of nearly medium size, sending forth no branches nor leaves above ground, but with a certain woolliness adhering to it on account of which it could not be aptly figured by me. Both men and women are said to be harmed by it. It appears to be of a sweetish taste and moderately hot. Ground up and applied to painful joints it is said to give relief. Wonderful properties are attributed to this root (if any faith can be given to what is commonly said among them on this point). It causes those devouring it to be able to foresee and to predict things; such, for instance, as whether on the following day the enemy will make an attack upon them; or whether the weather will continue favorable; or to discern who has stolen from them some utensil or anything else; and other things of like nature which the Chichimecas really believe they have found out. On which account this root scarcely issues forth, but conceals itself in the ground, as if it did not wish to harm those who discover it and eat it."[11]

From the above description, which applies perfectly to the plant from Zacatecas shown in fig, 2, it follows that the *Peyotl zacatecensis* of Hernandez is identical with *Lophophora williamsii*. Specimens of the drug collected at Zacatecas by the late Dr. Edward Palmer are shown in fig. 3. They bear little resemblance to the mushroom-like buttons shown in fig. 1, and it is not surprising that they should have been supposed to be distinct from the *teonanacatl* by the early Spanish writers.

RAIZ DIABOLICA, OR DEVIL'S ROOT

By this name it was designated by Padre José Ortega, who tells of its use by the Cora Indians in his Historia del Nayarit, published anonymously at Barcelona in 1754, and republished under his own name in 1887. In describing their nocturnal dances he writes as follows:

"Close to the musician was seated the leader of the singing whose business it was to mark the time. Each of these had his assistants to take his place when he should become fatigued. Nearby was placed a tray filled with *peyote* which is a diabolical root (*raiz diabolica*) that is ground up and drunk by them so that they may not become weakened by the exhausting effects of so long a function, which they began by forming as large a circle of men and women as could occupy the space of ground that had been swept off for this purpose. One after the other went dancing in a ring or marking time with their feet, keeping in the middle the musician and the choir-master whom they invited, and singing in the same unmusical tune (*el mismo descompasado tono*) that he set them. They would dance all night, from 5 o'clock in the evening to 7 o'clock in the morning, without stopping nor leaving the circle. When the dance was ended all stood who could hold themselves on their feet; for the majority from the *peyote* and the wine which they drank were unable to utilize their legs to hold themselves upright."[12]

The early missionaries were opposed to the drug not so much on account of its physiological effects upon the Indians but because of its connection with certain superstitious rites connected with their primitive religion. Eating the *teonanacatl*, or *peyotl*, was declared by the padres to be almost as grave a sin as eating human flesh. In a little religious manual published by Fray Bartholomé García in 1760, for the use of the missionaries to the Indians of San Antonio, Texas, the following questions, to be used in the confessional, are printed:

"Has comido carne de gente?" (Hast thou eaten flesh of man?)

"Has comido el peyote?" (Hast eaten the peyote?)[13]

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[10] Sahagun (1499-1590). Hist. general de las cosas de Nueva España (ed. Bustamente) 3:241. 1830.

[11] Hernandez (1514-1578). De Hist. Plant. Nov. Hisp. 3:70. 1790.

[12] Ortega, Padre José (d. 1700). Hist. del Nayarit, pp. 22-23 (new ed.) 1887.

[13] García, Fr. Bartholomé. Manual para administrar los Santos Sacramentos etc. p. 15. 1760.

PEYOTE OF ZACATECAS, ***Lophophora williamsii***

This form of the narcotic drug was called by the early Spanish missionaries "Raiz diabolica," or Devil's Root. Photograph of material in the Economic Collection, U. S. Department of Agriculture, collected at Zacatecas, Mexico, by the late Edward Palmer. (Fig. 3.)

The name *teonanacatl* is now obsolete. The drug is called by various names among the Indians using it: *xicori* by the Huicholes of Jalisco; *hikori*, or *hikuli*, by the Tarahumaris of Chihuahua; *huatari* by the Cora Indians of the Tepic mountains; *kamaba* by the Tepehuanes of Durango; *ho* by the Mescalero Apaches of New Mexico, who formerly ranged as far south as Coahuila; *seni* by the Kiowas; and *wokowi* by the Comanches, some of whom formerly lived in the state of Chihuahua. The name *peyote* has survived as a general commercial term; and the mushroom-like discs from the Rio Grande region are now widely spread among the northern Indians of the United States under the misleading names of "mescal buttons" or "mescal beans," as well as under the Nahuatl name *peyote*.

This name is of Aztec origin, derived from *peyotl*, the Nahuatl word for "cocoon." That its application to Lophophora was not general in early times is shown by the fact that Dr. Leonardo Oliva, professor of Pharmacology at the University of Guadalajara, declared it a singular thing that the *peyote* was regarded by the Mexicans as a plant having the virtue of giving unusual endurance to those using it, and the power of walking great distances without tiring. The only plant known to him by this name was a yellow-flowered Composite, with velvety tuberous roots, which from their form and indument might easily be likened to the cocoon of a moth.[14] As a matter of fact this name is still commonly applied to several species of Cacalia, the principal one of which, *Cacalia cordifolia*, is common in the vicinity of Guadalajara, Jalisco, in the drug markets of which the root is offered for sale under the name *peyote*.

CACALIA ALSO CALLED PEYOTL

The genus Cacalia belongs to the section Senecioneae, which includes Arnica, Tussilago, and other medicinal plants. To this genus should be referred the *Peyotl xochimilcensis* and the *Nanacace* of Hernandez, both of which are composites endemic in the neighborhood of Xochimilco, in the valley of Mexico, having a single stem growing from the middle of a cluster of nut-like tubers, with a terminal cluster of yellow-flowered rayless heads subtended by a scarious involucre. They should not be confused with the narcotic cactus called peyotl or peyote.

The peyote of Guadalajara, *Cacalia cordifolia*, was first described botanically by Kunth from specimens collected by Humboldt and Bonpland at Santa Rosa, Mexico. Its tubers, about the size of walnuts or hickory nuts, are covered with soft woolly hairs. From the center one of the cluster rises a single smooth terete stem bearing alternate, thickish, conspicuously net-veined leaves. The lower leaves are long-petioled, the upper ones, near the terminal inflorescence, are short-stemmed and much smaller. The blades are roundish or broadly ovate, cordate at the base and angled on the margin. The flower heads are arranged in the form of a corymb, with many tubular 5-toothed flowers crowded on a naked flat receptacle, subtended by an involucre cupshaped in form, composed of many narrow acute teeth. There are no marginal ray-flowers. The disc-flowers have both stamens and pistils, the latter with an exserted forked stigma. The pappus is pilose, somewhat resembling thistle-down when mature.

Fig. 4 shows the woolly tubers, reticulate leaves, and mature infloresense of *Cacalia cordifolia*, photographed from material in the United States National Herbarium, collected by the writer in February, 1907, in the vicinity of Guadalajara, state of Jalisco, Mexico.

Other specimens in the herbarium are from the Pedregal, or lavabeds, near Tlalpan, in the Federal District of Mexico, corresponding very closely with the descriptions of *Peyotl xochimilcensis* of Hernandez; and from Alvarez, state of San Luis Potosi, where the tubers, locally known as *cachan*, are offered for sale in the drug-markets as an aphrodisiac and a remedy for sterility.

THE GENUS LOPHOPHORA

The genus Lophophora was based by Coulter upon a small plant described in 1845 by Lemaire, in the Allgemeine Garten-Zeitung, under the name *Echinocactus williamsii*. This plant, though suggesting certain echinocacti by its form differs essentially from all species of that genus in its fruit, which is devoid of scales, and resembles the smooth club-shaped "chilitos" of the Mamillarias. The plant is also devoid of spine-bearing areoles. In 1886 it was referred to the genus Anhalonium, which it resembles in its flowers and fruits, but from the type of which it differs in several important features.

The genus Anhalonium, defined by Lemaire in 1839, proved to be identical with the genus Ariocarpus previously established by Scheidweiler, the type of which, *Ariocarpus retusus*, described in 1838, is specifically identical with the plant described the following year by

[14] "Es singular que los mexicanos miraban el *Peyote* (el que conozco es de las Compuestas . . .) como un medicamento propio para dar aptitud á andar sin cansarse . . ." Oliva, Lecc. de Farmacologia 2:392. 1854.

PEYOTE OF JALISCO, *Cacalia cordifolia*, **H. B. K.**

A member of the Composite, or daisy family, bearing velvety tubers: closely allied to the *Peyotl Xochimilcensis* of Hernandez. The tubers, called *peyotl* ("cocoons"), have medicinal properties, but they are not narcotic. Photograph of specimen in the U. S. National Herbarium collected near Guadalajara in 1907 by W. E. Safford. Photograph natural size. (Fig. 4.)

Lemaire as *Anhalonium prismaticum*.[15] This fact was recognized in 1845, by Salm-Dyck, who, however, adopted the generic name *Anhalonium*.[16] On account of the laws of priority the generic name Ariocarpus must be retained and its synonym Anhalonium be dropped.

In the genus Ariocarpus (Anhalonium) the tubercles are very prominent, usually more or less triangular or pyramidal in shape, and imbricating somewhat like the scales of an artichoke. The lower and upper parts are very different, the former comparatively thin and flat, while the upper exposed triangular part is very thick and hard. The lower surface of the tubercles is smooth and keeled, the upper surface is plane, as in *Ariocarpus retusus;* or convex and irregularly mamillate, with the acuminate apex bearing a woolly pulvillus, as in *Ariocarpus furfuraceus;* or more or less fissured and presenting a warty appearance, as in *Ariocarpus fissuratus*. One of these species is figured by Lumholtz under the name of *hikori sunami*,[17] and it is said by him to be more powerful than the common *hikori sunami* (*Ariocarpus williamsii*), but he offers no evidence that it has narcotic properties. The Indians declare that if you wear this plant as an amulet the bears cannot harm you nor the deer run away from you. The latter superstition is also held in connection with the closely related *Ariocarpus kotschubeyanus*, commonly called "pezuña de venado," (fig. 5) probably on account of the close resemblance of its tubercles to the hoof of a deer.

In the genus Lophophora the tubercles are quite unlike those of Ariocarpus (Anhalonium), being devoid of a differentiated upper part and having the lower part broad and rounded. Instead of being developed into pyramidal or triangular projections the tubercles often coalesce into broad continuous vertical or somewhat spiral ribs (fig. 7), and in young specimens the plant appears almost smooth, with the tubercles separated by shallow impressed lines (fig. 9).

LOPHOPHORA WILLIAMSII

Lophophora williamsii (*Anhalonium williamsii* Lemaire) is a succulent spineless cactus, usually shaped like a turnip or carrot with a depressed-globose or hemispherical head bearing low inconspicuous tubercles and a tapering tap root. The tubercles occur normally in longitudinal ribs, but in some forms of the plant they are arranged spirally or irregularly. In the center of each tubercle there is a flower-bearing areole with a dense tuft of erect hairs, from the midst of which the flower issues. When mature the tuft of hairs persists as a pulvillus in the form of a pencil or brush of hairs. Unlike the plants of the genera Echinocactus and Mamillaria there is no spine-bearing areole. The flower (fig. 6) is very much like that of an Ariocarpus, without a well-defined calyx, but with the outer floral leaves sepal-like and the inner ones petal-like and rose-tinted, with a darker median line on the back of each, giving to it a feather-like appearance. The stamens are numerous, with white filaments and bright yellow anthers; and the style bears four pale yellow stigmas projecting above the mass of stamens. The ovary is devoid of scales, in which respect it differs from that of the genus Echinocactus, and the smooth crimson or rose-colored club-shaped fruit resembles that of a Mamillaria. The plants grow either solitary, or, more frequently, in clusters of several from a common base.

Lophophora williamsii is quite variable, sometimes its ribs instead of being vertical are more or less diagonal or spiral, and instead of being separated by straight grooves the latter are sinuous; or the tubercles may be irregularly arranged. One form was described by Hennings as a distinct species under the name *Anhalonium lewinii;*[18] but the type plant described and figured by him was a boiled up "mescal-button" obtained from Parke, Davis & Co., of Detroit, Michigan, in all probability gathered in the vicinity of Laredo, Texas. In this form the ribs are usually thirteen in number separated by strongly sinuous grooves (fig. 9). Sometimes there are twelve ribs or even as few as nine; while in the typical *L. williamsii* there are usually eight ribs separated by straight or almost straight lines, or sometimes as many as 10. It has been wrongly asserted that the petals of *L. lewinii* are yellow: typical plants of this form now blooming in the cactus house of the United States Department of Agriculture (May, 1915) have rose-tinted flowers in no way distinguishable in form or color from those of *L. williamsii*. Indeed, in specimens collected by Lloyd in Zacatecas typical plants of *L. williamsii* and *L. lewinii* are to be found in the same cluster growing from a common base. Another form (fig. 10) departs from the typical *L. williamsii* even more than the plant figured by Hennings. It has the tubercles more or less irregularly arranged and separated into angular areas by intersecting lines. In young plants the surface is smooth, but in older plants (fig. 8) the tubercles are often prominent. At first the writer was inclined to separate this form from both *L. williamsii* and *L. lewinii*, but after carefully comparing a number of specimens the three types seem to be connected by intermediate forms, and they cannot, therefore, be specifically distinct. Indeed as they sometimes grow from the same base it would be improper even to designate them as varieties.

GEOGRAPHICAL DISTRIBUTION

The general range of the genus Lophophora is from southern Texas

[15] See Scheidweiler, Bull. Acad. Royale des Sciences de Bruxelles 5:492, 1 pl. 1838. Lemaire, Cact. 1, 1839.

[16] See *Anhalonium retusum* Salm-Dyck, Cact. Hort. Dyck. 15. 1845.

[17] Scribners Magazine 16:451. 1894.

[18] See Hennings, Gartenflora 37:410, figs. 1-4. 1888.

DEER-HOOF CACTUS

Ariocarpus kotschubeyanus, a plant with supposed magic properties, highly prized by Indians of northern Mexico, who declare that if the hunter wears this cactus (here shown natural size), the deer can not run away from him. It probably owes this prestige to the resemblance of its tubercles to the hoofs of a deer. (Fig. 5.)

FRUIT AND FLOWER

Flower of *Lophophora williamsii* (at the right) with rose-tinted petals, issuing from a tuft of hairs, while the fruit (shown at the left) is pink or crimson. Drawing natural size. (Fig. 6.)

along the valley of the Rio Grande, from the mouth of the Pecos River south-eastward, to southern Querétaro, Mexico. Definite localities in which plants have been collected are the following:

Texas.—Mouth of the Pecos River, *William Lloyd;* vicinity of Laredo, *Mrs. Anna B. Nickels* (specimens now growing in the cactus house of the U. S. Department of Agriculture); near Ojuelos, *C. Ochoa* (dried specimens in the form of "mescal buttons" in the economic collection of the U. S. Department of Agriculture); near Aguilares (specimens sent by parcel post to the Menominee Indians, now in possession of the Bureau of Chemistry).

Tamaulipas.—In the vicinity of Nuevo Laredo, *Mrs. Anna B. Nickels;* near Camargo, south shore of the Rio Grande at the mouth of the Rio San Juan, *E. A. Goldman*, of the U. S. Biological Survey.

Nuevo Leon.—Vicinity of Monterrey, *Professor Emilio Rodriguez*, (specimens growing in the cactus garden of the Colegio Civil, at Monterrey).[19]

Coahuila.—Cerro del Pueblo, near Saltillo, *Dr. Edward Palmer* (living plants in cactus house, U. S. Department of Agriculture; dried plants in economic collection).

Chihuahua.—Near Jimenez, in the Sierra de Amole (locality in which the Tarahumari Indians collect their supply for ceremonial purposes); near Santa Rosalía de Camargo, in the Sierra de Amargosa (also visited by the collecting expeditions of the Tarahumari Indians, as stated by Lumholtz).

San Luis Potosi.—Vicinity of Real de Catorce as cited by *Diguet* (locality whence the Huichol Indians obtain their supply).

Zacatecas.—Vicinity of Cedros, near Mazapil, near northern boundary, *Professor F. E. Lloyd* and *Dr. E. Chaffey* (living plants in the cactus house of the U. S. Department of Agriculture; also dried specimens from the market of the city of Zacatecas in the economic collection).

Querétaro.—Near Higuerillos, not far from the city of Querétaro, *Dr. J. N. Rose* (specimen in cactus house of the Department of Agriculture).

CHEMICAL HISTORY OF THE DRUG

Attention was called to the use of this plant as an intoxicant by the Indians by Mrs. Anna B. Nickels of Laredo, Texas, who collected material for Parke, Davis and Co., of Detroit, Michigan, and for other wholesale dealers in drugs. Mrs. Nickels sug-

[19] See Safford, W. E., "Cactaceae of Northeastern and Central Mexico," in Smithsonian Report for 1908, p. 528 *pl.* 3, *fig.* 5. 1909.

gested that a chemical and therapeutic study of the plant be made, and stated that the plant was also used for "breaking fevers," and that the tops cut off and dried were locally known as "mescal buttons." The accompanying photograph of this veteran cactus-lover and assiduous collector, in her cactus garden at Laredo, was taken by David Griffiths of the U. S. Department of Agriculture.

A serious study of its properties was first begun in 1888, by Dr. L. Lewin of Berlin, who used for the purpose specimens obtained from Parke, Davis, and Company. It was afterwards studied by Dr. Arthur Hefftet of the Pharmacological Institute of the University of Leipsic; and, in the United States, by a group of persons at Washington, centering in the Bureau of American Ethnology, and including as associates the Division of Chemistry of the Department of Agriculture for chemical analysis; Drs. D. W. Prentiss and Francis P. Morgan of the department of Materia Medica and Therapeutics of the Columbian University, for the study of its physiological properties; and the Botanical Division of the Department of Agriculture for the settlement of botanical questions. The material for the studies carried on in this country was supplied by James Mooney of the Bureau of American Ethnology. The chemical analysis was made by Ervin E. Ewell, who announced his results in a paper entitled "The Chemistry of the Cactaceae," read before the Washington Section of the American Chemical Society, April 9, 1896.[20]

Dr. Lewin obtained from the drug an alkaloidal substance which he called anhalonin. This substance was a brown, syrup-like liquid, having an intense alkaline reaction. From it Heffter obtained three alkaloids; the first, which he called anhalonin, was in the form of brilliant, colorless, needle-shaped crystals; the second was in the form of non-lustrous, white rhombic tables; the third was an amorphous and very poisonous alkaloid left behind by the mother liquor.

Mr. Ewell found, in addition to the alkaloids, at least two resinous bodies, and a wax-like substance insoluble in cold alcohol but soluble in hot alcohol, petroleum ether, and chloroform. The resinous bodies, of a dark brown color and thick consistency, have the characteristic taste and odor of the moistened drug itself. It was suggested that the drug's activity might be due to these resinous bodies rather than to the alkaloids. One marked peculiarity of the plant is that about one-half its ash proved to be potassium chloride—a proportion greater than that hitherto found in any other plant.[21]

PHYSIOLOGICAL ACTION

Further investigations are about to be made in the Bureau of Chemistry by Dr. Lyman F. Kebler, chief of the division of drugs, and Dr. Francis P. Morgan, whose work in this drug has already been referred to.

The various accounts of the effects of Lophophora differ considerably; but nearly all of those who have experimented with it, including Dr. S. Weir Mitchell, agree in the statement that it produces beautiful color visions. The pupil becomes dilated and remains in this condition for some time, often for twenty-four hours, and at the same time there is a slight loss of the power of accommodation and consequent disturbance of vision. Depression of the muscular system has been observed as one of its effects, either well marked or indicated only by inactivity and lazy contentment; and sometimes this was followed by partial anesthesia of the skin after the effects of the drug began to disappear. Sometimes the patient was seized with nausea and vomiting, caused perhaps by the bitter and unpleasant taste of the drug when first put into the mouth. In some cases there was a marked loss of the sense of time. The effects of the drug have been compared with those of Indian hemp (*Cannabis indica*), which has found its way from the Eastern Hemisphere to Mexico and the southwest United States, where it is known as *marihuana;*

[20] See Ewell, Erwin E., "The Chemistry of the Cactaceae," in Journ. Amer. Chem. Soc. 18: 624-643, 1896.

[21] Prentiss, D. W. and Morgan, Francis P., in Therap. Gazette 19, Sept. 16, 1895, p. 579.

LOPHOPHORA WILLIAMSII

Typical form with defined ribs. Photograph of specimen in the Cactus House of the U. S. Department of Agriculture, collected in 1910, on the Hacienda de Cedros, near Mazapil, state of Zacatecas, Mexico, by Dr. Elswood Chaffey. Photograph natural size. (Fig. 7.)

but instead of the exciting effect of the latter, Lophophora produces rather a state of ideal content, with no tendency to commit acts of violence.

A detailed account of the experiments of Drs. Prentiss and Morgan was published in the Therapeutic Gazette of September 16, 1895, pp. 580-585.[22]

CEREMONIAL USE BY THE INDIANS

The first to bring to public notice the ceremonial use of this narcotic by existing tribes of Indians was James Mooney of the Bureau of American Ethnology, in a paper read before the Anthropological Society of Washington on November 3, 1891. His attention had been directed to it while making investigations among the Kiowas, who are descendants of one of the tribes known to the Aztecs by the name of "Chichimecas." Mr. Mooney found that these Indians attribute divine powers to the drug and the ceremony attending its use is of the nature of a religious rite

[22] See also Prentiss and Morgan. "Therapeutic uses of Mescal Buttons." Therap. Gazette 20:4. 1896.

ANOTHER TYPE OF LOPHOPHORA

Form described by Hennings as a distinct species, *Anhalonium lewinii*, but often occurring in the same cluster with the typical form, growing from the same root. Photograph of specimen in the Cactus House of the U. S. Department of Agriculture, collected in the state of Zacatecas, Mexico, in 1908, by F. E. Lloyd. Photograph natural size. (Fig. 8.)

in which all the tribes of the southern plains take part.

The Kiowas and other Indians of Oklahoma receive the greater part of their supply of the drug from traders who bring it from the vicinity of Laredo, Texas, in the form of "mescal buttons," which are identical with the *teonanacatl* of the ancient Mexicans. Like the ancient Mexican feasts referred to above, their meetings are nocturnal, usually beginning Saturday night. A summary of Mr. Mooney's account was published in the Therapeutic Gazette of September 16, 1895. A more detailed description was published by Mr. Mooney the following January, in the same journal, from which the following extracts are taken.

"The ceremony occupies from twelve to fourteen hours, beginning about 9 or 10 o'clock and lasting until nearly noon the next day. Saturday night is now the time usually selected, in deference to the white man's idea of Sunday as a sacred day and a day of rest. The worshipers sit in a circle around the inside of the sacred tipi, with a fire

blazing in the center. The exercises open with a prayer by the leader, who then hands each man four mescals, which he takes and eats in quick succession, first plucking out the small tuft of down from the center. In eating, the dry mescal is first chewed in the mouth, then rolled into a large pellet between the hands, and swallowed, the man rubbing his breast and the back of his neck at the same time to aid the descent. After this first round the leader takes the rattle, while his assistant takes the drum, and together they sing the first song four times, with full voices, at the same time beating the drum and shaking the rattle with all the strength of their arms. The drum and rattle are then handed to the next couple, and so the song goes on round and round the circle—with only a break for the baptismal ceremony at midnight, and another for the daylight ceremony —until perhaps 9 o'clock the next morning. Then the instruments are passed out of the tipi, the sacred foods are eaten, and the ceremony is at an end . . . The dinner, which is given an hour or two after the ceremony, is always as elaborate a feast as the host can provide. The rest of the day is spent in gossiping, smoking, and singing the new songs, until it is time to return home."[23]

AMONG THE TARAHUMARIS

Lumholtz, in his account of the plant-worship of the Tarahumari Indians of the southwestern Chihuahua, mentions several kinds of cacti which they regard with superstitious veneration; but there is no evidence that any of these have narcotic properties except the "hikori huanami," which is the typical *Lophophora williamsii*. A species of Ariocarpus (probably *A. fissuratus*) was sold to him under the name of "hikori sunami," and was declared by the vendor to have certain magical powers; but he did not see it used as an intoxicant. Much that Lumholtz relates in connection with the ceremonial use of the narcotic hikori appears extravagant and fanciful; but it is undoubtedly true that the Tarahumari Indians, like their more southerly neighbors the Coras and Huicholes, have been led by the wonderful visions induced by the plant to attribute to it supernatural powers. Even the Christians among them salute it and make the sign of the cross when approaching it, and it is often carried by them as a charm or amulet. They declare that Hikori sits next to God and is called "uncle," because it is God's brother.

It will be shown later that a similar superstition is common among some of the Indian tribes of the United States who pay to the plant divine homage. In some of their religious societies there is a ceremony of baptism in which the candidate is sprinkled with an extract of the plant, and also a kind of communion in which the plant is eaten as an incarnation of the Deity, or the flesh of God.

Lumholtz gives an account of the expeditions of the Tarahumaris in quest of hikori, describing their consecration with copal incense before starting out, their ten-days' journey to the land of the Hikori, the erection of a cross on their arrival, the superstitious observances attending the gathering of the plant, which recall the stories of the early European herbalists regarding the mandrake and other magic plants, and the ceremonies attending their return.

The Indians of the village go out with music to welcome the travellers, bearing their precious burden; and at night there is a festival of teswin-drinking and dancing in honor of the plant. The hikori is piled in a heap at the foot of a cross, and is sprinkled with teswin, which is grateful to it; and the next day a sheep or even an ox or two goats are sacrificed in its honor. The wild heathen Indians living in caves or under overhanging cliffs in the barrancas, when they hear of the return of the expedition, come to buy supplies of the hikori for their own use. "One plant," says Lumholtz, "costs a sheep, and the buyer holds a feast in honor of his

[23] Mooney, James. "The Mescal Plant and Ceremony." Therap. Gazette 20: 7. 1896.

purchase, and repeats the feast at the same time every year."[24]

USE BY THE HUICHOLES OF JALISCO

The ceremonies attending the acquisition and use of the drug by the Indians of the Nayarit mountains of Jalisco and Tepic were described by Léon Diguet in 1899. These Indians belong to the tribes known as Huicholes, Coras, Tepehuanes, and Tepecanos. The Coras, whose use of the *raiz diabolica*, as described by Padre Ortega, has already been noted, now obtain their supply from the Huicholes. The latter send expeditions across the state of Zacatecas to Catorce in San Luis Potosi, where the plant is endemic. The specimens from Zacatecas in the Economic Collection of the Bureau of Plant Industry are not at all mushroom-like, but resemble dry pieces of radishes or carrots sliced longitudinally, or small, terminal fragments covered with silky wool, such as those described by early writers as "*peyote de Zacatecas*." (See fig. 3.) By the Huicholes the drug is known neither as *peyote* nor *teonanacatl*, but as *xicoli*, or *hicuri*, which is identical with the name *hikori* applied to it by the Tarahumari Indians.

According to Diguet the Huicholes collect the plant in October. The expedition lasts about one month, and its return is an occasion for celebration. "Those who take part decorate their hats and their hair with feathers and paint on their faces the distinctive attributes of their caste and of their gods. After having made an offering of peyote upon their altars they distribute pieces of it to all those they meet; a supply of peyote is kept for the feasts which will take place during the course of the year; the rest is sold to those who did not take part in the expedition. . .

"In eating the peyote the Indians chew the pulp of the plant, which has been cut up into small pieces, and at first spit out the saliva which at the beginning dissolves a bitter principle having a very disagreeable taste, then they absorb the active principle which dissolves little by little in the saliva."[25] According to Diguet the Indians regard the drug as food for the soul, and revere it on account of its miraculous properties. The manifestation of the hallucinations which it produces a little after the absorption of its active principle is held to be a supernatural grace by which men are permitted to communicate with the gods; and, moreover, "in using the drug with moderation the partaker is endowed with

TEXAS TYPE

Specimens of Lophophora from the vicinity of Laredo, Texas; the upper one a typical *L. williamsii*, with eight ribs separated by straight grooves; the lower one identical with "*L. lewinii*," with 13 ribs separated by sinuous grooves. Photographes from plants growing in Cactus House of U. S. Department of Agriculture; natural size. (Fig. 9.)

[24] See "Tarahumari Dances and Plant-worship." Carl Lumholtz, in Scribner's Magazine, October, 1894. Vol. 16, pp. 438-456.

[25] Diguet, Léon. "La Sierra du Nayarit et ses Indigènes." Nouvelles Arch. Missions Scientifiques 9: 622-24. 1899.

energy which permits him to overcome great fatigue and to endure hunger and thirst for five days."[26]

PRESENT USE IN THE UNITED STATES

Efforts have been made to prevent the spread of the drug among the Indians of the United States, and action has been taken in the courts to prosecute those who have been instrumental in procuring it and furnishing it. One of the most recent cases is that of the United States versus an Indian named Nah-qua-tah-tuck, alias Mitchell Neck, of the Menominee Indian Reservation, Wisconsin, accused of furnishing intoxicants to certain Indians, in violation of the law. Dr. Francis P. Morgan, of the Bureau of Chemistry, was summoned as a Government expert. The trial developed the following facts:

On March 15, 1914, the accused brought a supply of the drug in a dress suit case to the house of an Indian family named Neconish, situated a short distance north of the village of Phlox, Wisconsin, near the western boundary of the Menominee Reservation, at which place there was a meeting of a religious nature. The drug had been received by parcel post from Aguilares, Texas. The participants first made a line about the house to keep out the evil spirits, and then invoked God, begging him to make all of them good and to keep them from evil. The peyote was next distributed, and when it was eaten caused the partakers to see the evil things they had done and showed them the good things they ought to do.

The ceremony began about 9 o'clock in the evening. One witness testified that shortly after having eaten four buttons he could see pictures of various kinds when his eyes were shut. First he saw God, with a bleeding wound in his side. This vision vanished when he opened his eyes, but reappeared when he closed them again. Then he saw the devil with horns and tail, of the color of a negro. Then he saw bad things which he had done before, bottles of whiskey which he had drunk, a watermelon which he had stolen, and so many other things that it would take all day to tell of them. Then he saw a cross with all kinds of colors about it, white, red, green and blue. He was not made helpless. He stated that he could have walked had he wished to do so, but that he preferred to sit still and look at the pictures.

Another witness testified that he ate the peyote so that his soul might go up to God. The witnesses who testified at this trial declared that the peyote helped them to lead better lives and to forsake alcoholic drinks. The defendent was acquitted on the ground that the meeting was one of a religious nature.

THE PEYOTE SOCIETY

Thomas Prescott of Wittenberg, Wisconsin, testified that there is a regularly organized association among the Indians called the Peyote Society, also known as the Union Church Society, of which he had been a priest for seven years. In the weekly ceremonies of this society the peyote is either eaten or taken in the form of tea. In his opinion the effect of the peyote is to make better men of the Indians. Many of them were formerly common vagabonds, liable to commit all sorts of crimes when under the influence of alcohol. After becoming members of the peyote society, however, they gave up drink, established themselves in regular homes, and lived sober and industrious lives. In relating his personal experience he made the following statements:

"We boys, before we got this peyote, was regular drunkards; so when I was drunk I was lying on the road somewhere sometimes, and I got no home nor nothing. Before I got this I did wrong and everything else. Now, since I got this peyote, it stopped me from drinking, and now, since I used this peyote, I have been sober, and today I am sober yet . . . I see a good and a bad when I eat that peyote. When I eat that peyote then it teaches me my heart; I know anything that is right and what is wrong. That is the way peyote works for good and works for God, and that is how we worship. . . . When

[26] Diguet, Léon. loc. cit. p. 621.

I took this peyote I could see myself when I used to be drunk; I could see the bottles which used to have my whiskey and alcohol in; I could see myself lying drunk in the road. That is the way it shows us the bad and teaches us the good. . . . We could have our meetings without this peyote; but we see some more coming—a new person—he wants to use it—when he takes this peyote then he believes God. That is why we use it for. Without this, why, they would not believe anybody."[27]

Dr. Morgan gave to the court an account of his experiments bearing upon the physiological action of the drug administered in his presence to several young men who had volunteered for the purpose. The chief effect noticed was the production of visions of various kinds: of moving objects, constantly changing designs and figures of landscapes, friezes, balls of beautiful colors in constant motion. Suggestions of definite objects also brought up visions of that object. These visions were seen only when the eyes were closed. The pupil of the eye was made larger, and this enlargement lasted till the following day; the pulse became slower at first but increased when a greater quantity of the drug was taken; there was evidence of muscular depression with a disinclination to exertion of any kind; and there was a loss of conception of space and time and, in some cases, symptoms of dual personality, not unlike that caused by hashish (*Cannabis indica*). The after effects, however, were insomnia, while hashish eating is usually followed by sleep. In this respect it also differs from opium and somewhat resembles the active principles of coffee and coca (*Erythroxylon coca*). Dr. Morgan further testified that as far as he knew no therapeutic or remedial value of the drug had been established.

At a meeting of the Lake Mohonk Conference in October, 1914, several papers relating to the effects of this drug upon the Indians were read and affidavits from two Omaha Indians were quoted. Fron one of the latter, I take the following extracts:

AMONG THE OMAHA INDIANS

At the meetings of the Society "before they sing they pass the peyote around. They begin taking this medicine along about dark, and when they pass it, ask you how many you want, and they often try to persuade you to take more than you want. The medicine does not work right away, but after it begins to take effect along toward midnight they begin to cry and sing and pray and stand and shake all over, and some of them just sit and stare. I used to sit in their range right along, and ate some of their medicine, but after I ate it the first time I was kind of afraid of it. It made me feel kind of dizzy and my heart was kind of thumping and I felt like crying. Some of them told me that this was because of my sins. It makes me nervous, and when I shut my eyes I kind of see something like an image or visions, and when my eyes are open I can't see it so plain. One of these fellows took twelve beans, or twelve peyote, sitting with some girls . . .

THE SOUTHERN TYPE

Young plant of Lophophora from Higuerillos, state of Queretaro, Mexico, the southern limit of the genus. Collected in 1905 by Dr. J. N. Rose. Photograph natural size. (Fig. 10.)

[27] From ms. report of the case of the United States versus Nah-qua-tah-tuck, alias Mitchell Neck, in the archives of the Bureau of Chemistry. 1914.

After I have taken twelve peyote I saw a mountain with roads leading to the top and people dressed in white going up these roads. I got very dizzy and I began to see all kinds of colors, and arrows began to fly all around me. I began to perspire very freely. I asked to be taken out of doors. At that time it was 20° below zero. I felt better when I got out of doors. When I went in again I began to hear voices just like they came from all over the ceiling and I looked around in the other room and thought I heard women singing in there, but the women were not allowed to sing in the meetings usually, and so this was kind of strange. . . . After eating thirty-six of these peyote I got just like drunk, only more so, and I felt kind of good, but more good than when I drink whiskey, and then after that I began to see a big bunch of snakes crawling all around in front of me, and it was a feeling like as if I was cold came over me. The treasurer of the Sacred Peyote Society . . . was sitting near me, and I asked him if he heard young kittens. It sounded as if they were right close to me; and then I sat still for a long time and I saw a big black cat coming toward me, and I felt him just like a tiger walking up on my legs toward me, and when I felt his claws I jumped back and kind of made a sound as if I was afraid, and he asked me to tell him what was the matter, so I told him after a while. I did not care to tell at first; but I made up my mind then, after what I saw, that I would not take another one of these peyotes if they gave me a ten dollar bill. . . . In this Sacred Peyote Society they have a form of baptism and they baptize with the tea made from stewing the peyote, and they baptize 'in the name of the Father, and the Son, and the Holy Ghost,' the Holy Ghost being the peyote. Then you drink some of the tea and they make signs on your forehead with the tea and then take an eagle's wing and fan you with it. I heard an educated Indian and he said in a meeting on Sunday morning, 'My friends, I am glad I can be here and worship this medicine with you; and we must organize a new church and have it run like the Mormon Church.' "[28]

USE IN ANCIENT MEXICO

From the preceding description of a meeting of the Sacred Peyote Society held by the Winnebagos and Omahas in 1914 I turn back to the first account we have of the *Teonanacatl* feasts of the Aztecs, written by Padre Bernardino Sahagun in the sixteenth century—before Sir Francis Drake set out upon his voyage round the world—before tobacco which, under the name of *picietl*, the Mexicans also worshipped, was first brought to England.

"The first thing eaten at the party was certain black mushrooms which they call *nanacatl*, which intoxicate and cause visions to be seen, and even provoke sensuousness. These they ate before the break of day, and they also drank cacao (chocolate) before dawn. The mushrooms they ate with syrup (of Maguey sap), and when they began to feel the effect they began to dance; some sang; others wept because they were already intoxicated by the mushrooms; and some did not wish to sing, but seated themselves in their rooms and remained there as though meditating. Some had visions that they were dying and shed tears; others imagined that some wild beast was devouring them; others that they were capturing prisoners in warfare; others that they were rich; others that they had many slaves; others that they had committed adultery and were to have their heads broken as a penalty; others that they had been guilty of a theft, for which they were to be executed; and many other visions were seen by them. After the intoxication of the mushrooms had passed off they conversed with one another about the visions which they had seen."[29]

The following description of a religious meeting in July, 1626, at which sacred mushrooms were administered in the

[28] Daiker, F. H., "Liquor and Peyote a Menace to the Indian," in Report of the Thirty-second Annual Lake Mohonk Conference, October, 1914, pp. 66, 67.
[29] Sahagun, Bernardino. Hist. Nueva España (ed. Bustamente) 2: 366. 1829.

MRS. ANNA B. NICKELS IN HER CACTUS GARDEN

This veteran cactus lover, a resident of Laredo, Texas, called attention to the narcotic properties of Lophophora, and supplied to Parke, Davis & Co. material with which to investigate the drug. Photograph by David Griffiths, U. S. Department of Agriculture. (Fig. 11.)

form of communion, is related by Padre Jacinto de la Serna, at that time beneficiary of Tenantzingo.

"To this meeting had come an Indian, native of the pueblo of Tenango (about 25 kilometers from Toluca) and grand master of superstitions, named Juan Chichiton (or "John Little-dog"), who had brought some of the mushrooms that are gathered in the *monte*, and with these he had performed a great idolatry. But before proceeding with my story I wish to explain the nature of the said mushrooms, which in the Mexican language are called *Quauhtlananacatl* ("wild mushrooms"). When I asked the *licenciado* Don Pedro Ponce de Leon what they were like, he said that these mushrooms were small and yellow, and that they were collected by priests and old men, appointed as ministers for these impostures, who would proceed to the place where they grow and remain almost the whole night in prayer and in superstitious conjuring; and at dawn, when a certain little breeze known to them would begin to blow, then they would gather the narcotic, attributing to it deity, with the same properties as *ololiuhqui* or *peyote*, since when eaten or drunk, they intoxicate those who partake of them, depriving them of

their senses, and making them believe a thousand absurdities.[30]

"This man, Juan Chichiton, brought these mushrooms one night to a house where there was a gathering for the celebration of a saint's feast. The saint stood on the altar and below the altar were the mushrooms, with some pulque, and fire. All night long the *teponaztli* (wooden drum made from a hollowed log) kept time to the singing, and after the greater part of the night had passed, the said Juan Chichiton, who was the priest of that solemnity, administered to all those congregated at the feast mushrooms and pulque after the manner of communion, winding up the celebration with an abundant quantity of pulque; so that the mushrooms on their part and the pulque on its, took away their reason, which was a pity. The said Juan Chichiton fled soon afterward, nor could I obtain information about the others who took part, in order to chastise them, with the exception of Leonor Maria, whom I kept as a prisoner in my house for having joined in the idolatry which they performed with the mushrooms.

"I asked the said *licenciado* Don Pedro Ponce de Leon in what manner these creatures perform their acts of witchcraft in working harm to others; and he told me that in making their threats and menaces they strike themselves on the breast as at the *Sanctus* with the tips of their fingers and then, opening their hand, they make a gesture as if hurling something in the direction of the person whom they are menacing or wish to bewitch, saying: 'You shall pay me for that, as you will see!' But concerning other words and things which they say and do by order of the devil in these *embustes*, never or scarcely ever could anything be ascertained; though it stands to reason that they must have them as a pact with the devil; and he, who is the author of all, closes their mouths, so that there may be no means of remedying the evil."[31]

SUMMARY

After comparing the preceding accounts of the use of narcotics by the ancient Mexicans and by the Indians of the present day, separated in time by three centuries and in space by thousands of miles, there can remain no doubt that the mushroom-like peyote used by our own Indians in the United States, which we know to be identical with the sacred *hikuli*, or *hicori*, of the Sierra Madre Indians, is the same drug which was called *teonanacatl*, or "sacred mushroom," by the Aztecs. According to the earliest writers, it was endemic in the land of the Chichimecas, the early home of our Apaches, Comanches, and Kiowas, which is also the source of the modern supply. The ancient Mexicans, like the Huicholes and Tarahumaris of the present day, obtained their supply of the drug through the medium of messengers, consecrated for the purpose, who observed certain religious rites in collecting it, and who were received with ceremonial honors on their return. Although the Indians on our northern reservations now receive it through the medium of the parcel post; yet they attribute to it the same divine properties as the ancient Mexicans and like them combine its worship with the religion they have received from Christian missionaries. It is only natural that those who are engaged in the work of Christianizing and uplifting our Indians should try, like the early Spanish missionaries, to stamp out its use. On the other hand many of the Indians who use the narcotic declare that they take it as a kind of sacrament or communion, and that it helps them

[30] Lumholtz gives a somewhat similar account of the expeditions of the Huichol hikuli-seekers: their prayers before starting forth on their journey, their priestly character, their worship of the God of Fire, the importance attached to their dreams while on the road, the ceremonial shooting of arrows on their arrival in the hikuli country, their votive offerings, their prayers to the five winds, and their petition to the hikuli not to make them crazy, the gathering of the sacred plants and of the discharged arrows covered with dew, and the return home with its attending ceremonies. Lumholtz, Carl—Unknown Mexico 2: 126-136. 1902.

[31] Jacinto de la Serna, "Manual de los Ministros para el conocimiento de sus idolatrías y extirpacion de ellas," in Documentos inéditos para la Historia de España, vol. 104, p. 61. Madrid, 1892.

to turn from wickedness and lead good lives.

A knowledge of botany has been attributed to the Aztecs which they were far from possessing. Their plant names show that their classification of plants was not based upon real affinities, and it is very probable that they had not the slightest notion of the difference between a flowering plant and a fungus. Certainly they applied the names *nanacatl* and *nanacace* to both fungi and flowering plants and the name *peyotl* to both the narcotic cactus, Lophophora, and to the tuber-bearing composite, Cacalia. The botanical knowledge of the early Spanish writers, Sahagun, Hernandez, Ortega, and Jacinto de la Serna, was perhaps not much more extensive: their descriptions were so inadequate that even to the present day the chief narcotic of the Aztecs, *Ololiuhqui*, which they all mention, remains unidentified.[32] They knew these narcotic drugs only in their dry state; and the general appearance of the *peyotl* brought from the vicinity of Zacatecas (fig. 3) was so very different from the *teonanacatl* from the more northerly region inhabited by the Chichimecas (fig. 1) that the two forms might easily have been regarded as coming from distinct plants.

As far as the author knows, this is the first time that the identity of the "sacred mushroom" of the Aztecs with the narcotic cactus known botanically as *Lophophora williamsii* has been pointed out. That it should have been mistaken by the early Spaniards for a mushroom is not surprising when one notices the remarkable resemblance of the dried buttons to peltate fungi, and also bears in mind that the common potato (*Solanum tuberosum*) on its introduction into Europe was popularly regarded as a kind of truffle, a fact which is recorded by its German name, *Kartoffel*, or *Tartuffel*.

[32] Sahagun describes two plants bearing the name *Ololiuhqui:* one, which is not narcotic, with a fleshy turnip-like root, leaves like those of a Physalis, and yellow flowers; the other, also called *Coaxoxouhqui*, or "green snake," with highly narcotic seeds. (Op. cit. vol. 3, pp. 264, 241.) Hernandez describes the latter as round like those of Coriander, and says that they are produced by a twining plant called *Coaxihuitl*, or "snake-weed," which has fibrous roots and longish white flowers (Hern. ed. Recchi, p. 145); while Serna does not describe the plant, which he probably never saw, but compares the form of the seeds to that of lentils: "semilla a modo de lantejas que llaman Ololiuhqui." (Op., cit. p. 163.) Hernandez thought the plant might be the same as the *Solanum maniacum* of Dioscoroides. Dr. Manuel Urbina, of the National Museum of Mexico, declared it to be *Ipomoea sidaefolia* of Choissy; but this identification, while agreeing with Hernandez's illustration, lacks confirmation through investigation of the chemical properties and physiological action of the seeds of this species; and it is not known that any of the Convolvulaceae are narcotic, though many of the Solanaceae, which have somewhat similar flowers, are highly so. It is very strange that Mexican botanists living in the country of the Ololiuhqui have not solved the mystery of its identity.

Mulattoes in the United States

Elaborate statistics regarding the Negroes in the United States are given by the Bureau of the Census in its recently-issued bulletin 129, compiled by Dr. Joseph A. Hill. "Of the 9,827,763 Negroes enumerated in 1910, 7,777,077 were reported as 'black' and 2,050,686 as 'mulatto.' In 1850 the percentage reported as mulatto was 11.2 It had advanced but little in 1870, being only 12%, but since 1870 the proportion of mulattoes in the Negro population appears to have increased very materially, reaching 15.2% in 1890 and 20.9 in 1910. Considerable uncertainty necessarily attaches to this classification, however, since the accuracy of the distinction made depends largely upon the judgment and care of the enumerators. Moreover, the fact that the definition of the term 'mulatto' adopted at the different censuses has not been entirely uniform may affect the comparability of the figures to some degree. At the census of 1910 the instructions were to report as 'black' all persons who were 'evidently full-blood Negroes' and as 'mulatto' all other persons 'that have some proportion or perceptible trace of Negro blood.' "

SWEET CHERRY BREEDING

Scientific Improvement only Beginning—Breeders in Ignorance as to Nature of Material with Which They Are Dealing—Needs of Growers—Self-sterility of Cultivated Varieties.[1]

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At the present time the sweet cherry varieties grown in this country number among the hundreds. A large percentage of these varieties are of old world origin. Though seedlings of American origin were named and introduced at a comparatively early period in the history of American pomology, it is only within recent years that American varieties of commercial importance have appeared. Among a number of reasons for this is the fact that while the sweet cherry has not proved to be particularly well adapted to much of the territory east of the Rocky Mountains, at the same time it has not practically refused to grow there, like certain other fruits of European origin. Consequently, there has not been the same amount of effort devoted to its breeding in Eastern America, as the many good qualities of the fruit would seem to warrant. On the other hand, the last fifty or seventy-five years have shown that the sweet cherry reaches a high degree of perfection on the Pacific Coast; and with the rapid development of a commercial cherry industry there, new varieties of more or less promise have appeared.

With the hundreds of European varieties upon which to build an industry it might seem that there would be little need of breeding new varieties for the section in question, especially since such a large percentage of those in existence seem to do as well here as in the countries of their origin. In fact such a need has not been felt until comparatively recently—as market demands have come to be more exacting. Today certain sections have come to cater to particular markets. Only by being able to send a particular type of cherry to particular markets at certain seasons can competition with other sections be largely avoided and the largest profits be realized. For instance, certain California sections are mainly interested in an extra-early firm shipping variety that can be placed upon the Eastern markets in late April and early May; certain eastern Oregon and Washington valleys are desirous of growing very late shipping varieties that can be placed upon those same markets in late July and early August; still other sections desire a light colored canning variety that can be grown with the Napoleon to lengthen the harvesting season for the cannery. Many other "vacant places," if such they may be called, might be mentioned in our present catalogue of cherry varieties; but enough have been indicated to suggest the nature of the practical problems presented to the breeder by the cherry industry.

OBSTACLES TO BREEDING

It would seem that these objects not only ought to be possible of attainment, but that many of them ought to prove comparatively simple problems for the plant breeder. However, when the situation is investigated it is found that the breeder has very little in the way of detailed information regarding the materials with which he must work. With but few exceptions nothing is known regarding the ancestry of present day varieties. Most of them originated as chance seedlings. When

[1] Report to the committee on research in plant-breeding, American Genetic Association. Submitted by the committee.

supposed parentage is given for some of them in standard pomological works it is often found that there is only circumstantial evidence to indicate such parentage. Perhaps the seedling sprang up near a tree of some other known variety and hence was assumed to be its offspring.

Of course the cherry breeder can make large numbers of crosses between varieties he thinks might combine to give him the particular qualities he desires, but in this he would be very largely dependent upon chance for his results. No body of facts is available which will enable him to select parents that he can depend upon for transmitting certain qualities. It would seem that one of the first things for the cherry breeder to do is to make a careful analysis of the varieties now in his possession, to determine if possible what is the nature of their gametic constitution, what really are the unit characters or factors, or the combinations of unit characters or factors, that they possess; and to determine how these factors or combinations of factors are transmitted. This is not essentially different from the work that is necessary when starting breeding studies with other plants; but the problems associated with an analysis of his materials are somewhat more difficult than usual for the cherry breeder, because at least a large per centage, if not all, of the varieties with which he would work are self sterile. The inter-sterility of a number of the apparently more promising varieties still further complicates the whole question. A certain amount of progress in this direction is being made, but it will probably require many years to acquire the data that are really fundamental to scientific cherry breeding work. This is not stating that valuable varieties will not originate as chance seedlings within the near future, just as Lambert, Bing and a number of others have originated during recent years. It is to be expected that valuable additions to our cherry list will come in that way. Furthermore, varieties of merit are almost certain to appear incidental to the careful experimental work necessary in studying the inheritance of characters in the sweet cherry group.

Race Betterment Conference

The second Race Betterment Conference will be held at San Francisco August 5-8 inclusive. Arrangements are in charge of a committee with David Starr Jordan as chairman, Dr. Herbert Stolz of Lane Hospital, San Francisco, as secretary.

NEW PUBLICATIONS

THE GREAT SOCIETY—A PSYCHOLOGICAL ANALYSIS, by Graham Wallas, London School of Economics and Political Science. Pp. 382, 8vo., price $2. New York, The Macmillan Company, 66 Fifth avenue, 1914.

"This book is written with the practical purpose of bringing the knowledge which has been accumulated by psychologists into touch with the actual problems of present civilized life." It should be particularly helpful to eugenists, now that they are coming generally to realize that the success of their propaganda depends largely on the expertness with which they use applied psychology. The author himself is in warm sympathy with the biological study of the question, declaring that "social psychology can never lead men to wise practical conclusions unless it keeps in view its relation to that science of human breeding which Sir Francis Galton named Eugenics." He analyses the important human dispositions in an extremely readable way, showing how they can be used for the improvement of the organization of society. A perusal of it would tend to broaden and clarify the ideas of almost every social worker.

BLACK AND WHITE AYRSHIRES

Colors as Old as the Breed—Rare in America but Much More Common Abroad—No Indication of Mixed Ancestry—Possible Origin of the Breed.

A. H. Kuhlman

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BLACK and white cattle are well known to all Americans interested in dairying, because of the popularity of the Holstein-Friesian breed, but those colors are not commonly associated with Ayrshires in this country, and it is a surprise to most travelers to find black and white cattle in the Ayrshire district of Scotland. My attention was first attracted to them at the Kilmarnock (Scotland) Show in April, 1914, where several of them were on exhibition, one of which (Fig. 12), was among the prize winners. The black and white Ayrshire cattle as the illustrations (Figs. 12 and 13) show, have the typical Holstein markings in that the black and white are distinctly separated and there seems to be a tendency for the spotting to occur in large patches rather than in numerous small spots as commonly seen in Ayrshires.

In the scale of points as adopted in 1906 by the Ayrshire Cattle Herd Book Society of Great Britain and Ireland, the following description is given of the color of the breed:

"Red of any shade, brown or these with white, mahogany and white, black and white; or white; each color distinctly defined."

The description of the color of the breed as given in the Herd Book in 1884, however, shows that black and white was not always popular with the members of that organization as is shown by the following reference to it:

"Color, red of any shade, brown, or white, or a mixture of these, each color being distinctly defined. Brindle or black and white is not in favor."

William Bartlemore in describing[1] his ideal of the breed in 1889, makes the following statements:

"As regards the color, it is much a matter of fancy. The prevailing one is flecked brown and white, but there are many splendid animals all brown while the leading show yard color during the last ten years has been white, with brown or dark brown sides of head. Few dairies in Scotland of any size at the present day are without their flecked black and white Ayrshire and strange to say, that color is much in demand by gentlemen who keep a few cows for family use."

AMERICAN STANDARD

The American and Canadian Ayrshire breeders have adopted a uniform scale of points which closely resembles the British, but does not recognize the black and white cattle. It refers to color as follows:

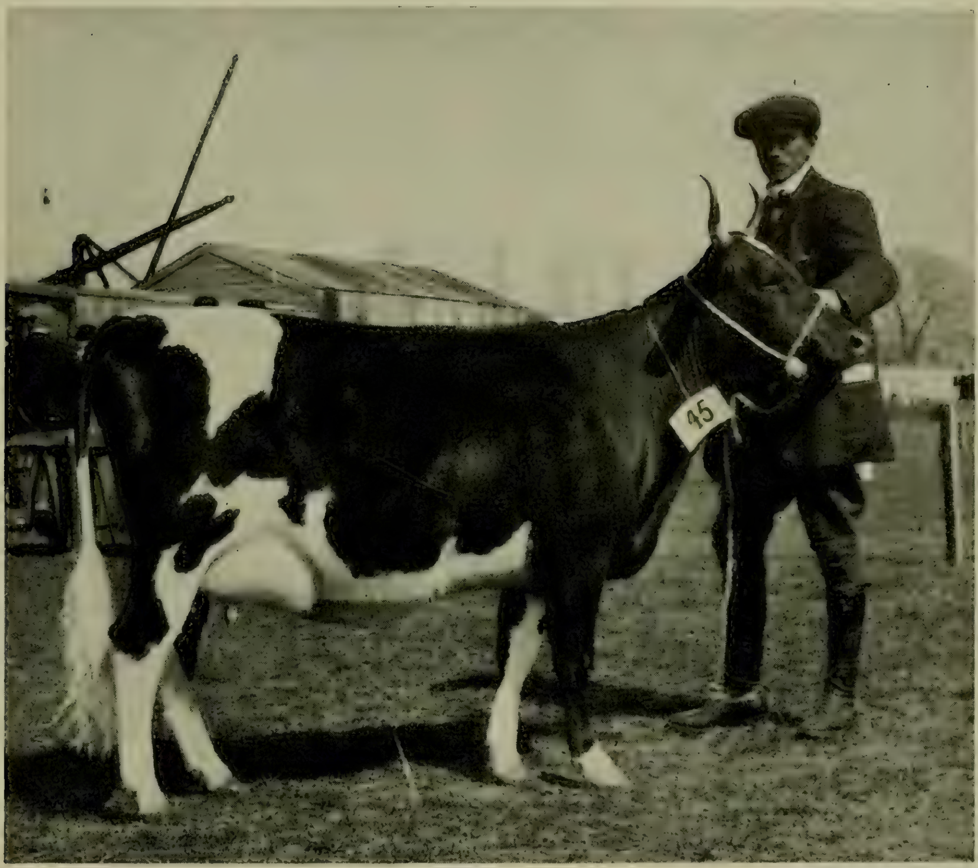
"Color. Red of any shade, brown or these with white; mahogany and white, or white; each color distinctly defined."

Very few black and white Ayrshires have been imported into this country, because American buyers think the color shows the presence of Holstein blood.

The red color of the Ayrshire is apparently a different kind of red than that of the Shorthorn or the Red Polled cattle. It seems to be a peculiar red which usually shades into a mahogany or wine colored tinge producing a color commonly recorded as brown in the Ayrshire Herd Book. The term brown as used in this way, includes many shades of red ranging from a bright red to a very dark brown.

Further observation and inquiry in

[1] Speir, J., Early History of the Ayrshire Breed of Cattle, Glasgow, Aug. 13, 1909.



BLACK AND WHITE AYRSHIRE PRIZE WINNER

Heifer exhibited at the Kilmarnock (Scotland) show, 1914. As will be noticed, her markings are quite like those of a typical Holstein. Black and white are almost unknown colors in an American Ayrshire, but this prejudice against them is not founded on reason. (Fig. 12.)

Scotland showed that many of the leading breeders of pure bred Ayrshires have one or more black and white animals in their herds. It is claimed by many that they are better producers than the white, brown, or brown and white animals. Some also claim that a black and white Ayrshire cow from a black and white dam, always produces calves of that color even if bred to a bull that is white and brown.

A count of several hundred animals in the local markets showed that from 3 to 4% of the grade Ayrshires were black and white. Grades of this color are considered good producers and often bring a higher price on the market than grades of the more usual color. Some breeders who do not admit the superior milking qualities of the black and white cows, keep them for "good luck" as they say or for the contrast they add to the color of the herd.

A study of several volumes of the herd book, brought out some interesting details. Volume 8 of the Ayrshire Herd Book, published in 1885, is the first one in which any mention is made of the color of the individual animals recorded in it and in Volume 9 this record is not complete, for the color of about one hundred cows entered in it

is not given. However, it does show that even at that time black and white cattle were accepted for registration.

Brown as used in these tabulations includes all shades of red and likewise, for convenience, red and white animals are tabulated with those that are brown and white. It may be assumed that the terms brown or white as used in the herd book do not always refer to a self brown or self white, but rather to animals that would ordinarily be called brown or white by the casual observer. For example, some of the so-called white cows have brown eye lashes and dark colored eyes which would not be present in a true self white. The designations brown and white, and white and brown are freely used in the herd books, the former apparently referring to animals appearing more brown than white and the latter to those showing more white than brown, but it would seem as if there would be many cases in which it would be hard to determine which should be used.

A comparison of Tables I and II shows a decrease from 1886 to 1913 of about 10% in the number of white and brown cows. Table II shows a remarkable similarity in the per cent. of cows and bulls of the different colors, which is not the case in Table I. It is probable that this difference may be largely due to greater care being exercised in the later registration work. Table II also shows that there are only about one-half as many black and white cows as either red or white.

Table III shows in more detailed form the marking of the bulls referred to in Table II, as they are entered in the herd book. It brings out an interesting point that is well known among Ayrshire breeders and exporters, namely,

TABLE I

Summary of Registration in Vol. 9, of the Ayrshire Herd Book

Color	Cows		Bulls	
	Number	Per cent.	Number	Per cent.
White	53	13.35	26	23.64
Brown	59	14.86	10	9.09
Black and white	9	2.26	....	....
Brown and white	191	48.12	38	34.55
White and brown	85	21.41	36	32.72
Total	397	100.00	110	100.00

TABLE II

Summary of Registration in Vol. 36, Published 1913

Color	Cows (pedigreed)		Bulls	
	Number	Per cent.	Number	Per cent.
White	176	3.91	54	5.42
Brown	145	3.22	32	3.21
Black and white	67	1.48	15	1.50
Brown and white	4119	91.39	896	89.87
Total	4507	100.00	997	100.00

TABLE III

Summary of Bulls Registered in Vol. 36

Color	Number	Per cent.
White	54	5.42
Brown	32	3.21
Black and white	15	1.50
Brown and white	339	34.00
White and brown	418	41.93
White, brown cheeks	79	7.93
White, brown neck	27	2.71
White, dark cheeks	20	2.00
White, dark spots	8	.80
Flecked	3	.30
Marked	2	.20
	997	100.00

the tendency to select sires with much white (Figs. 14 and 15) to satisfy popular fancy. It shows that of almost 1,000 bulls registered in that volume, 34% were brown and white, 41.93% were white and brown and 12.64% had the brown restricted to the head and neck. The latter form of marking is one of the most popular at the present time. Almost all of the black and white bulls now used for service are marked in this way and it is doubtful if very many bulls marked like the black and white cows (Figs. 12 and 13), are kept for breeding purposes today, but bulls with black or very dark jaws or cheeks are very popular. It is interesting to note that by careful selection the color pattern of a spotted breed can be greatly changed.

The so-called "White horse with black eyes,"[2] is a striking illustration of what may be accomplished along this line. By careful selection from brown and white spotted animals, a strain of horses was produced in Denmark and also at Hannover which are entirely white in color of hair and skin, but are distinguished from albinos in that the eyes always remain black.

The Ayrshire Herd Book Society is one of the very few breed associations that still makes provision for the registration of animals not the offspring of recorded ancestors. All animals entered in the Herd Book are divided into three groups: (1) those entered with a number or in the Herd Book proper, (2) those entered in Appendix A, and (3) those entered in Appendix B. Subject to the approval of the committee in charge of this work, a cow or heifer becomes eligible for entry in Appendix B, on one of the first three following conditions in addition to the fourth:

1. The sire of such a cow or heifer must be entered in the herd book.

2. She must be an individual of high merit, as shown by winning a prize at an agricultural show in a class for Ayrshires.

3. She must be able to attain a high standard of production by producing an authentic milk yield within one year and in addition an examining committee must declare that she possesses the true characteristics of the Ayrshire breed.

4. In addition to fulfilling one of these three requirements, the owner and breeder must sign a statement declaring that she is a pure bred Ayrshire.

The female offspring of a dam entered in Appendix B, sired by a recorded bull, is eligible for entry in Appendix A. Cows entered in either Appendix A or B are entered by name but without a number. No bulls can be entered in either Appendix A or B.

An animal is eligible for entry in the Herd Book proper, that is with a

[2] Walther, A. R., Beiträge zur Kenntnis der Vererbung der Pferdefarben, 1912.

CHARACTERISTIC COLOR DISTRIBUTION

In the black and white Ayrshires, the colors usually occur in large patches, and are distinctly separated. Other colors in the Ayrshire more usually occur as numerous small spots. The cow here shown is the dam of the heifer illustrated in Fig. 12. (Fig. 13.)

number, if both sire and dam are entered with numbers, or if the sire is recorded and the dam is entered in Appendix A of any volume.

BREED IS KEPT PURE.

Under these provisions it is possible for the progeny of many animals that have been bred pure for many years to qualify for registration in the herd book. That Ayrshire breeders are taking advantage of these provisions is shown by the numbers recorded in Vol. 36, in which 4,507 cows and 895 bulls are entered with numbers, 1,128 cows are entered in Appendix A, and 1,848 cows in Appendix B. This seems like introducing a large amount of new blood into the breed every year, but it must be remembered that these animals, for all practical purposes, have exactly the same kind of breeding as the pedigreed animals. Then, too, this breed is confined to a rather small area into which comparatively few animals of other breeds have been introduced for breeding purposes for several centuries. Confinement to such a small section has the further advantage that the committees in charge can very easily obtain reliable information about the breeding of any herd.

Table IV shows that the per cents. of black and white cows in Appendices A and B are considerably higher than those shown in the preceding tables, but that does not prove that the black and white color is introduced into the breed by this method of registration, for Table I shows that Vol. 9 contained 2.26%, black and white cows, which would tend to indicate that black and white was present in the breed in the early stages of its development.

A CHAMPION AYRSHIRE BULL

Hobsland Perfect Peace, champion Ayrshire bull at Kilmarnock, Scotland, in April, 1914, and also at the National Dairy show in Chicago in October, 1914. His color is nearly white, the brown markings being almost exclusively confined to head and neck; and he represents very well the prevailing fashionable type of Ayrshire bull in this country. (Fig. 14.)

The study of the early history of the Ayrshire breed leads to several theories explaining the appearance of this black color as shown by the investigations of John Speir. Even though the Ayrshire is one of the most recent breeds, its origin is as great a mystery as any of the older ones. The original cattle of Scotland were black in color, small in size and had short horns. The Roman invasion brought other types of cattle into the country. The resulting fusion may have formed the basis for some of the later breeds.

As a much larger number of the Ayrshire cattle of today are white or almost white, when compared with the numbers of the early days some people think that the white color of the Ayrshire is a reversion to the color of some white ancestor like the wild white cattle of Cadzow Forest. It seems unlikely that the Ayrshire is in any way related to the Cadzow Forest cattle. Speir states that between 1865 and 1880 several bulls, mostly white in color, became noted prize winners. As a result they became very popular and in a few years their progeny was widely distributed. This easily accounts for the prevalence of many Ayrshires at the present time that are mostly white.

Other suppositions suggest Norwegian or Spanish origin, but nothing has ever been found to substantiate these claims. That Dutch cattle were used in the early formation of the British breeds is quite probable. Writers of the fifteenth and sixteenth centuries fre-

TABLE IV

Summary of Cows Registered in Appendix A and B of Vol. 36

Color	Cows Registered in Appendix A		Cows Registered in Appendix B	
	Number	Per cent.	Number	Per cent.
White	44	3.90	51	2.75
Brown	55	4.88	90	4.86
Black and white	39	3.45	111*	6.05
Brown and white	530	46.99		
White and brown	460	40.78	1596	86.34
	1128	100.00	1848	100.00

* This number included 13 black cows.

quently mention red and white, and black and white, but do not give any direct mention of Dutch cattle. No writer before 1600 mentions any breed that even remotely resembles the Ayrshire breed, but before 1800 the breed had spread over the county of Ayr and surrounding districts.

Before and during this period there was close connection and much trade with Holland. It is not unlikely that many of the cattle of that country were imported before 1600. That most of the Ayrshires are red and white instead of black and white, may be due to the fact that more of the former color were imported from Holland. For example, many red and white cattle are still found in some sections of Holland, and red and white seems to have been the common color of Dutch cattle before 1750. It may be that most of the British importations were selected from such cattle. It is true that there are many differences between the Dutch and the Ayrshire cattle of today, but these differences might be expected from differences in selection, food and environment during a period of several centuries.

Speir also states that the Dutch paintings between 1600 and 1750 usually represent cattle as red and white in color, but after 1750 black and white seems to have become the popular color.

Brody[3] in a very interesting discussion of the Ayrshires, also refers to the color and origin of the breed. The following free quotations are taken from his paper:

"The tendency towards partial albinoism is quite pronounced in Ayrshires. This is rather remarkable for the breed originally was very dark colored, but systematic selection for color, as practiced by the breeders, probably accounts for the change in color. During the eighteenth century only a few white markings were usually found, but as early as 1811 Aiton[4] found that there was a decided tendency towards a mixture of white and brown markings. That the darker colored animals were previously more common is also shown by the reproductions of the Ayrshires of the latter part of the eighteenth century as well as by the method of designating the white spotted animals that were employed by the breeders. Cows with a white face were called 'bassened,' those having white on the neck 'hawked,' those having white along the back or loin 'rigged' and if the switch of the tail was white they were called 'tagged.' This would seem to indicate that if white was present at all, it was confined to comparatively small areas and found on one part of the body only. Since that time a decided change has occurred with reference to

[3] Brody, Dr. Ladislaus, Die Ayrshires. Mitteilungen der Landwirthschaftlichen Lehrkanzeln der K. K. Hochschule für Bodenkultur in Wien. Aug. 18, 1914.

[4] Aiton, William., General view of Agriculture of the County of Ayr, 1811, Glasgow.

CHAMPION AT THE AYR SHOW

Howie's Sir Hugh, champion bull at the Ayr show in Scotland in 1914 and 1915. Most of the prominent sires now in use in herds of Ayrshires resemble this bull in being mostly white; but the preference for a predominantly white bull seems to have no sound genetic basis. (Fig. 15.)

the distribution of the color pattern in the Ayrshire."

The results of Brody's investigations of the color of the breed are given in the following table:

Color of Animals	Per cent.
Almost wholly or mostly white	35.24
Equally white and brown	33.34
Almost wholly or mostly brown	25.70
Black or black and white	5.72
	100.00

As nothing is said about registration in this connection, it may be assumed that this tabulation was made without considering it and it is very probable that similar results could be obtained in many sections of the Ayrshire district.

Among the many theories that are advanced as to the origin of the breed, he enumerates the following:

1. A local theory is that the breed was imported.

2. Some claim the breed was developed locally.

3. John Speir claims that the breed is of Dutch origin.

4. Professor Wallace thinks it descended from the *Bos longifrons*.

5. Sanson designates it as a hybrid breed tracing to the celtic cattle and showing certain resemblances to the Kerry.

From a study of the history of the British Isles as well as the skulls and other characteristics of the Ayrshire, Brody assumes that the breed is of celtic origin, had been bred pure for a long time and was brought into Scotland when the Celts were forced to withdraw before the Romans and later before the Anglo-Saxons. Of course these cattle resembled the present day

breed very little, and many changes have occurred since that time. Brody accepts Aiton's view of the later development of the breed.

"Aiton reports that the cattle of Ayrshire formerly were mostly black, with a white stripe along the back, white in the flank or face and had horns that were turned upwards and inwards."

"The present day breed was developed by introducing other blood, better care and selection. He states that about 1740 to 1800 a large number of Dutch as well as Shorthorn cattle were introduced and crossed with the native cattle. Which of the two were used more freely, is not certain, but as the Shorthorn was even then famous on the Island and also easier to obtain, this fact leads to the assumption that perhaps more Shorthorns than Dutch cattle were used. The striking feature about it is that as a result of such unsystematic introduction and crossing, such a remarkably uniform breed was obtained which for many decades has maintained its individuality. Two things may have aided in this—(1) the introduction of foreign blood may have been confined to a relatively short period and (2) as the work of development was probably begun in the large herds the smaller breeders soon fell into line and followed their example. Then, too, information about the merits of any animal or system of breeding would be quickly disseminated in such a small section as that in which the breed was developed."

Whatever may have been the origin of the black in Ayrshires, it is certain that this color is as old as the breed itself and black and white Ayrshires are just as pure as those that show other colors.

ANNUAL MEETING OF THE ASSOCIATION

THE American Genetic Association will hold its annual meeting at Berkeley, California, August 2–6, inclusive. The sessions now scheduled are as follows:

Monday afternoon, August 2, joint session of the American Genetic Association with section for Animal Husbandry, American Association for the Advancement of Science.

Tuesday morning, August 3, opening session A. G. A.

Tuesday afternoon, August 3, second session A. G. A.

Wednesday, August 4, joint sessions with A. A. A. S. at Stanford University: "The Role of Variation and Heredity in Evolution."

Thursday morning, August 5, meeting of plant-breeding section, A. G. A.

Friday morning, August 6, joint meeting with section for Horticulture, A. A. A. S.

Friday afternoon, August 6, closing session of A. G. A.

This program is subject to change. **The complete outline of the meetings will be published about July 15, and a copy will be sent to any member who requests it.** Address the secretary at Washington, or Professor E. B. Babcock, University of California, Berkeley, California.

All meetings of the association will be open to the public. There will be an opportunity for discussion of each paper.

Following is an incomplete list of the papers to be presented, embracing probably two-thirds of the whole. The titles of these papers are subject to change.

E. D. Ball and Byron Adler of the Utah Experiment Station, "Is Egg-laying in the White Leghorn a Unit Character?". Results of tests extending over number of years and designed to show in what way the capacity of high egglaying is inherited will be presented.

E. E. Barker, Cornell University, "Color Studies in the Morning Glory."

S. Boshnakian, Cornell University, "A Better Method for Representing Mendelian Segregation," and "A Coefficient of Squarehead-Form Necessary for the Statistical Study of Density in Wheat."

Leon J. Cole, University of Wisconsin, will describe some of the experimental breeding done there to determine the facts of inheritance in pigeons.

G. N. Collins and J. H. Kempton of the Bureau of Plant Industry will describe crosses of Tripsacum and Euchlaena, two grasses, which may throw light on the ancestry of cultivated maize.

B. O. Cowan, Santa Monica, California, "Inbreeding."

R. A. Emerson, Cornell University, "Genetic Correlation between Plant Colors and Aleurone and Endosperm Colors in Corn."

Albert F. Etter, Briceland, California, will describe his methods of strawberry breeding. Professor Roy E. Clausen of the University of California will show lantern slides of the subject.

Irving Fisher, professor of economics at Yale University, has promised to speak on the relation between eugenics and sociology.

A. C. Fraser, Cornell University, "Heredity in Phaseolus."

E. F. Gaines, Pullman, Wash., "The Inheritance of Qualitative Factors in Small Grains;" results obtained at the Washington State Experiment Station.

Alexander Galbraith, DeKalb, Ill., "Inbreeding," a description of his experience with Clydesdale horses and other stock.

R. Ruggles Gates, University of London, "On Successive Duplicate Mutations" and "The Modification of Characters by Crossing."

A. W. Gilbert, Cornell University, "Color Inheritance in *Phlox drummondi*."

Frank M. Harding, secretary American Shorthorn Breeders Association, Chicago, Ill., "Inbreeding."

H. Hayward, Delaware Experiment Station, "Inbreeding."

A. C. Hottes, Cornell University, "Multiple Hybrids, with Special Reference to the Genus Gladiolus."

David Starr Jordan, Chancellor of Leland Stanford Junior University, "The Long Cost of War."

Wilhelmina E. Key, Hartland, Wis., "Creating a Eugenic Conscience."

H. E. Knowlton, Cornell University, "Studies in Pollen Germination."

Samuel C. Kohs, House of Correction, Chicago, Ill., "Eugenics and the Unconscious."

Isabel McCracken, Stanford University, "Notes on Silkworm Heredity, with Special Reference to theMoricaud Race."

C. L. Redfield, Chicago, Ill., "Dynamic Evolution."

G. P. Rixford, Bureau of Plant Industry, San Francisco, Cal., "The Pistacio Nut in the Southwest and Some Morphological Features in the Development of the Embryo."

A. J. Rosanoff, Kings Park State Hospital, Long Island, N. Y., "Preliminary Report of a Study of the Offspring of the Insane."

A. D. Shamel, Bureau of Plant Industry, Riverside, Cal., "Problems of the Navel Orange."

R. R. Slocum, Bureau of Animal Industry, Washington, D. C., "Poultry Breeding;" illustrated with motion pictures.

W. B. Swift, Boston State Hospital, Boston, Mass., "The Possibilities of Voice Inheritance."

W. T. Swingle, Bureau of Plant Industry, Washington, D. C., "Plant Breeding in Japan."

Ethel H. Thayer, Mendocino State Hospital, Talmage, Cal., "Cacogenic Problems in California."

C. C. Thomas, Cornell University, "Preliminary Observations on Variations in *Trillium grandiflorum* and *Podophyllum peltatum*.

E. N. Wentworth, Kansas State Agricultural College, Manhattan, Kans., "Sex-limited Inheritance."

G. L. Tundel, Cornell University, "Evolution of Celery" and "Disease Resistance in Celery."

The Surgeon General, U. S. Public Health Service, has promised to detail one of his assistants to speak on immigration through the port of San Francisco, as it bears on eugenics.

Several motion picture films will be shown, including one illustrating the horse breeding work of the U. S. Department of Agriculture.

A number of the papers will be illustrated with the stereopticon.

ETTERSBURG STRAWBERRIES

Successful Hybridizing of Many Species and Varieties in Northern California Leads to Production of New Sorts Which Are Apparently Adapted to Meeting Almost All Requirements.

Roy E. Clausen

Instructor in Genetics, College of Agriculture, University of California, Berkeley, Calif.

IN THE early seventies a Captain Cousins, in command of a freighter plying between North and South American Coast points, brought from Callao, Peru, to Eureka, California, some plants of the sand strawberry, *Fragaria chiloensis*, indigenous to that region. He turned these plants over to A. J. Monroe of Eureka, and from him Albert F. Etter of Briceland, California, obtained the strain of Peruvian Beach strawberry which he has since used so successfully in his strawberry breeding work. This strawberry crossed with an inferior third generation seedling of Sharpless x Parry gave, among twelve others, his first superior seedling, Rose Ettersburg. Since then Mr. Etter has made numerous other crosses, using not only the wild Peruvian beach strawberry, but the beach strawberries native to California as well, the wood strawberry of the interior of California, the Alpine strawberry, and in later times others in addition to these. Some 10,000 seedlings have been fruited in the course of the twenty years following the production of the Rose Ettersburg strawberry, and the success that has been achieved well merits the attention here given it.

Mr. Etter's success is unquestionably due to the skilful way in which he has united the advantageous characteristics of a number of distinct species and forms, and cannot, therefore, be considered intelligently without giving due attention to these forms. In the course of his work he has made a considerable collection of strawberry varieties and species, including a large number of the varieties grown commercially in the United States and several from French sources, besides the strictly wild species of which a number are represented.

The first and foremost of the species which Mr. Etter has used is *F. chiloensis*, the sand or beach strawberry. This strawberry is native to the Pacific Coast of the Americas and is distributed from South American points well up into Alaska, and has also been collected at Argentine points on the east coast of South America. In this region it is strictly coastal in its habitat, growing at most perhaps not more than 2 miles inland. It grows on the bleakest and most wind swept situations, enduring alike the sterile soil of the beach and the salt spray of the ocean. Even in Alaska, Georgeson[1] writes of it thus:

THE BEACH STRAWBERRY

"The species is known as *Fragaria chiloensis*. It grows along the coast from Muir Glacier to Prince William Sound and probably also in other places, but throughout this region it is quite abundant. Its favorite soil is the sand and gravel along the old beach line just above the reach of high water. It here disputes the possession of the surface with grasses and weeds of many kinds and is quite able to hold its own against them."

In fact wherever found it appears to be a notable characteristic of *F. chiloensis* that it is able by virtue of a deep rooting system and hardy foliage to endure the most unfavorable conditions with respect to the fertility of the soil and the available supply of moisture.

[1] Georgeson, C. C. An. Rept. Alaska Expt. Sta., 1909, p. 11.

STRAWBERRIES FOR LAWN PLANTING

The beach or sand strawberry (*Fragaria chiloensis*) which occurs almost from one end to the other of the Pacific coast, is so hardy and resistant to all sorts of unfavorable conditions, that it is often used in that region to cover slopes or exposed places, in landscape gardening. This photograph shows it so used, and flowering freely, on the university campus at Berkeley, California. (Fig. 16.)

But aside from these general characteristics of the sand strawberries of the Pacific Coast, the species shows a remarkable diversity of forms, so much so as to lend considerable support to the tendency of some systematists to sub-divide the group still further. Mr. Etter has growing at Ettersburg half a dozen strains of *F. chiloensis* from Chilean, Peruvian, and Californian sources and all of them possess distinct characteristics which would unmistakably separate them from one another, and all appear to present notable differences from the Alaskan form which Georgeson has used so successfully in his plant breeding work. Thus for example we have forms with light green foliage and petioles covered with a dense coarse pubescence. The California forms for the most part have glossy dark green leaves practically free from any pubescence. Some forms have characteristically long fruiting trusses, while in others the trusses are short. In some forms the berries are nearly white in color, while others bear distinctly red berries. The differences extend to every character, and they are mentioned here because they serve as

HYBRIDS ARE NOTED FOR VIGOR

The center row in this photograph is a collection of ordinary commercial varieties of strawberry; while on either side are rows of hybrids produced by Albert F. Etter. It is well known that, in general, hybridization tends to increase the vigor of plants and animals, and this fact is often turned to advantage in modern breeding. It is evident that the Ettersburg strawberries are much more vigorous growers than common commercial varieties which, although originally hybrids, have been propagated so long that they have lost most of the benefit accruing to them from their original hybridization. (Fig. 17.)

an indication of the extreme variability which consequently might be expected in the hybrids.

The two other species which have been used extensively in the hybrids thus far produced are *F. vesca semperflorens*, the Alpines, and *F. californica*, the native wood strawberry. Stock of the former was obtained by growing seedlings from seed supplied by John Lewis Childs of Floral Park, New York. Some of these seedlings bore red and others white berries, and some of the plants produced runners and others did not, as is characteristic of the Alpine strawberries. All of these forms were used in the hybridization work. The wood strawberry used was derived from local sources and displayed the characteristics usual for that species, namely free production of very small inferior berries and a tendency towards winter growing. These three represent all the wild species concerned in the hybrids considered in this article. Others are now being used, among them *F. cuneifolia*, a distinct and somewhat peculiar type from Oregon, and *F. chinensis* varieties originally derived from Chinese sources.

GARDEN VARIETIES USED

As a foundation for the work a number of common garden varieties which have met with some favor in California have been used. Among these are the Sharpless and Parry, previously mentioned, and of the others,

Michel's Early, Senator Dunlap, Marshall, Chesapeake, Crescent, William Belt, Bederwood, Dornan, and Australian Crimson have yielded promising hybrids. It is unnecessary to go into the characteristics of these, because they are well known and further because these characteristics, except in so far as they are common to all the strawberry varieties in general cultivation, would lend but little aid to a study of the hybrids which have been produced from them. Suffice it to say that the garden varieties which are represented in the pedigrees of the best of Mr. Etter's productions are not there because they have displayed any particular value in this respect compared with garden varieties which are not represented.

The methods which Mr. Etter uses in his strawberry breeding work are very simple but admirably adapted to the material with which he is working. In many cases advantage is taken of the fact that pistillate strains exist within the species and forms with which he is working, and in almost all his crosses such pistillate strains and varieties have been used as the mother parents. Shortly after the blossoms on these selected mother plants open a flower of the desired male parent is bound over it with a strip of muslin, and the pollen then is scattered over it by the thrips which work around in the blossoms and also by the mere contact of the two flowers. In case the desired female parent is perfect flowering the stamens are, of course, removed before pollination. The strip of muslin with the label attached to it remains over the fruit until it is ripe. When the fruits are ripe they are picked and enclosed in little muslin bags. They are then mashed together and hung up to ferment for a few days, after which the pulp is washed away from the seeds as thoroughly as possible. The seeds are sown immediately in specially prepared seed boxes in which spaces are marked off for each different cross, and there the young seedlings remain until they are strong enough to be transplanted to the field. No particular attempt is made to hasten germination, consequently under these conditions most of the seeds germinate the second year after sowing. Obviously these methods do not enable us to be absolutely sure of the parentage of the seedlings, but any doubt as to their hybrid nature would be soon dispelled by a study of the seedlings and their parent plants.

THOROUGH TESTS GIVEN

The second feature of Mr. Etter's methods lies in the thorough test to which all seedlings thus secured are subjected. They are first transplanted to the trial patch where they are planted in hills, usually three in each hill. Here they remain until they fruit. Those which prove inferior from the start are soon rooted up while those which seem to possess desirable qualities are given Ettersburg numbers and subjected to a further test in four to ten hill units. There they may be compared directly with previous selections which have made good and, if found especially worthy, they are further subdivided and propagated. Mr. Etter has no faith either in his own or anybody else's ability to pick out the varieties which will be successful by any other method than that of a thorough trial; and in the same way in selecting his parents for hybridization, he is guided only by the dictates of experience.

The selections which Mr. Etter has made have been based almost entirely on the commercial value of the characteristics that the seedlings have displayed under trial. The endeavor has been made to improve the strawberry in vigor, in quality of fruit with respect to texture, flavor, color, etc., in productiveness, and in such other characteristics as might increase its commercial value. A few freaks have been produced in the course of the work but they are merely by-products and very few of them have been retained. In the work several objects have been held in mind, such as the production of strawberry varieties particularly suitable to the home garden, the production of others suitable for canning, and the production of still other varieties suited to more or less special demands. Perhaps these

features may be best brought before the reader by a specific consideration of a few of the varieties which have been retained.

Rose Ettersburg, the first successful variety, is a hybrid of a third generation Sharpless x Parry seedling by Peruvian Beach. It is a strong, vigorous grower and produces large berries, always true to shape, and of a light pink or rose color, thus indicating its Peruvian Beach parentage. It is remarkable for its quality and fragrance, the flavor is decidedly different from other strawberries, and on that account desirable or undesirable according to individual tastes. It possesses the usual extreme vigor of the Beach hybrids, and has produced at the rate of 8 tons per acre on Mr. Etter's place without irrigation. Its light color and rather peculiar flavor would probably be against it at the present time as a general commercial variety. It is a splendid variety, however, for the home garden.

Ettersburg No. 121 is supposedly a direct hybrid of the two species Alpine x Cape Mendocino Beach. Like Rose Ettersburg it is very vigorous and productive; unlike Rose Ettersburg the berries are deep glossy red in color and even the flesh is intensely red to the center. This is one of the many Ettersburg varieties that pick without the hulls like blackberries and with about as little abrasion, a characteristic which is derived from the Alpines. The variety is notable for high quality and solidity. It has a full, sweet flavor that could not fail to be attractive to anyone who likes strawberries. The profusion of blossoms which it produces makes it a beautiful sight when in bloom. This is a variety of considerable commercial promise.

A COMPLEX HYBRID

Ettersburg Trebla, formerly Ettersburg No. 222, in contradistinction to Ettersburg No. 121 possesses a very complex pedigree as shown in the following outline:

- Ettersburg Trebla
  - Ettersburg No. 84
    - Seedling No. 3
      - Rose Ettersburg
      - *F. californica*
    - Unnumbered seedling
      - Cape Mendocino Beach
      - Rose Ettersburg
  - Ettersburg No. 114
    - Unnumbered seedling
      - *F. californica*
      - Rose Ettersburg
    - Alpine

When the derivation of Rose Ettersburg, as given previously, is considered it can be seen how complicated this pedigree is and how many species and varieties are included in it.

Out of this mixed ancestry has been derived the variety which Mr. Etter considers his best variety thus far. This variety evidently considers its mission in life to be the production of fruit, and splendid fruit at that. The berries are of medium size, deep red, and solid to the center. Eaten fresh it is a berry that would not appeal to most people on account of its high acidity, but in canning it develops a remarkably rich and pleasant flavor. Like Ettersburg No. 121 it picks without the hull and with scarcely any abrasion. At Mr. Etter's place it has produced at the rate of 20 tons per acre. The plants present a peculiar appearance at fruiting time when the heavy foliage is mostly weighed down by the large quantities of fruit produced and only a few stiff leaves remain erect. We have here a variety which is apparently particularly suitable for canning. The solidity of the berry is such that it has no tendency to break down during the canning process, and the deep color, high flavor, productiveness, and ease with which it may be prepared for canning are other features which make it an especially desirable variety on which to build up a strawberry canning industry.

Ettersburg No. 200 is a cross between Senator Dunlap and the Peruvian Beach strawberries. It is merely a unique novelty. The berries are small to medium in size, and with only a very faint pink color, very nearly white. The achenes (seeds), however, are deep red in color and set in deep depressions in the surface of the fruit. A single plant has borne as many as 200 berries at one time. It is strongly Peruvian Beach in its characteristics and is certainly a strange strawberry.

TWO TYPES OF STRAWBERRY BLOSSOM

Commercial varieties of strawberries fall in two classes: those with perfect flowers, including both stamens and pistils (as shown at the top of the photograph) and those whose flowers lack the male element, and are called pistillate. A flower of this type is shown at the bottom of the photograph. It is obvious that if plants of the second type are grown exclusively, the flowers cannot be fertilized, and will produce no fruit. It is therefore necessary for every grower to have at least some plants of the perfect-flowering type, in order to pollinate the blossoms and ensure a crop. It is not advisable to limit a planting to a single variety, even if this have perfect flowers, because although they will produce an abundance of pollen, yet it has been shown by experiment that better results are secured when cross-pollination takes place from some other variety. Photograph by Fairchild. (Fig. 18.)

These are typical examples of the results which have followed Mr. Etter's strawberry breeding work, and they are only a few cases selected as illustrations of these results. The most remarkable general characteristic of the hybrids is their extreme vigor leading to the production of a deep rooting system and of stiff, leathery, heat resistant foliage unlike any of the common garden varieties. On this account it is actually necessary to grow some of the varieties under not too favorable conditions lest they expend their energy in the production of a rampant vegetative growth at the expense of the production of fruit.

DIVERSITY OF TYPE

This extreme vigor, perhaps an illustration of the stimulating effects of crossing, gives the strong foundation to which many other desirable features have been added. Some of the hybrids produce fruit which is nearly white in color and from them we have a continuous series of varieties with respect to color of fruit up to those which produce deep glossy red fruit with intensely red flesh. The flavors are even more extensive in range. Many of them are peculiar and not easy to describe, some resemble the flavors of other fruits, banana, muskmelon, Tartarian cherry, raspberry, and so on; and we would not greatly exaggerate if we were to compare the range of flavors found here with that occurring in the apple. In acidity the hybrids vary from those which are insipid, watery, and practically tasteless to those which are very acid, lemon sour in fact; and some are full, rich, and sweet. The texture and quality of the flesh is another item to which Mr. Etter has given special attention, particularly with reference to use in canning, and for this he has had a wide range of forms from which to make selections. Some of the hybrids seem to possess practically no substance, they are extremely watery like many of the common garden varieties, and on canning naturally break down into a purée mixture with little solid matter in it. There are others which are somewhat firmer, but some of these do not possess the desired uniformity of texture—instead they are inclined to be fibrous. A few are firm and solid to the center with no suggestion of a core. These stand up well when canned. They remain firm and solid and retain their shape remarkably well. There is also naturally enough a large range of sizes and shapes from small to very large, from spherical to sorts which are very elongated or even irregular. Some of the varieties pick free from the hulls and others pick in the usual way, the former characteristic apparently representing a heritage from the Alpine race. This is a characteristic which is of considerable importance from a canning standpoint. In productiveness there are all degrees up to the 20 tons per acre limit of Ettersburg Trebla. A fairly large percentage of the varieties are imperfect flowering as might be expected on account of the use of such forms so extensively in the hybridization work; and some of these varieties have a tendency to produce irregular berries, apparently on account of imperfect fertilization. These then represent some of the variations found in the Ettersburg hybrid strawberries, and among the 200 or more which have been found worthy of further trial it is possible to please almost any taste or satisfy any demand.

WIDE ADAPTABILITY

The question naturally arises as to the adaptability of these hybrids to various environmental conditions, and on this question we unfortunately do not possess a very extensive knowledge as yet. Under the conditions obtaining in the northern coast region of California they have demonstrated their excellence and fitness. These conditions, however, are almost ideal for strawberry growing. The soil on which they have been grown is rich, newly cleared forest land, perhaps somewhat acid; the climate is mild, and there is sufficient rainfall to carry them through the fruiting season in good shape. The hybrids are being tested throughout California and at several experiment stations, and preliminary reports of

these trials are on the whole very encouraging. Thus in New York Taylor[2] has tested seventeen of the varieties which have been introduced, and even under the totally different conditions of that locality with respect to soil and climate he has found four of them good enough to include in his list of desirable varieties. It appears, therefore, that some will be found excellently adapted to other than the ideal conditions of Humboldt County. Their remarkable vigor and their deep rooting system and drouth resistant foliage would indicate an ability to withstand trying summer conditions with respect to heat and drouth, and such in fact is the case. The enduring qualities of *F. chiloensis* are, if anything, accentuated in the hybrids. The varieties undoubtedly deserve a wide and thorough trial, and the indications are that, when the story of that trial shall have been told, certain of the hybrids will have been found adapted to almost any condition under which strawberries are grown.

The work which Mr. Etter has done has great significance in practical strawberry breeding. Whether or not it has succeeded in producing varieties which are suitable for all the varied needs and conditions of strawberry growing is not so important as the fact that it has demonstrated the wonderful possibilities which lie in practical strawberry breeding, and has developed a method of attack of that problem which yields remarkable results. Most important of all is the demonstration of the fact that further hybridization of the common garden varieties of the strawberry, themselves supposedly largely *F. chiloensis* derivatives, with wild forms of that species results in a notable increase in vigor and in the production of new varieties superior in every respect to the commonly cultivated ones. Georgeson,[3] endeavoring to breed new varieties of strawberries suitable for Alaskan conditions by hybridizing their native *F. chiloensis* with a common garden variety, has found exactly the same thing to be true, and his enthusiastic accounts of the work remind one very much of the parallel results which Mr. Etter is securing under California conditions.

SECRETS OF SUCCESS

We have reported in this article the remarkable results which Mr. Etter has secured in thirty years of persistent and intelligent strawberry breeding. This success is due to the fact that he has become thoroughly familiar with the material with which he is working and has evolved a method of strawberry breeding which has proved very effective in the production of new, superior varieties. Essentially this method is the same as that which has been adopted by a number of successful plant breeders, namely that of hybridization followed by thorough trial and careful selection. The work of selection is of course simplified in the strawberry by the fact that vegetative propagation may be used to perpetuate any particularly excellent individual, and that perhaps with very little likelihood of any subsequent deterioration. The selection in effect has been made through several generations, as is usually necessary before the desired combinations of characteristics are secured. While the new varieties thus secured have not yet been thoroughly tested, present indications are that many of them will prove highly successful under a variety of conditions. At any rate a successful method of attack in strawberry breeding has been discovered, and these Ettersburg hybrid strawberries are a successful application of that method.

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[2] Taylor, O. M., Strawberry Varieties. New York Geneva Sta. Bul. 401, pp. 165-192, 1915.
[3] Georgeson, C. C. An. Repts. Alaska Expt. Sta., 1906-1913.

THE FIRST-BORN'S HANDICAP

Accumulation of Statistics Appears to Show That Eldest Members of a Family Are "Weighted"—Possible Explanations of the Fact.

REVIEW OF A BOOK BY KARL PEARSON

Director, Galton Laboratory for National Eugenics, University of London.

WHEN Karl Pearson, in 1907, published statistics which appeared to show that the first and second-born in any given fraternity or sibship were more likely to be attacked by tuberculosis and were, therefore, presumably constitutionally inferior, in that respect at least, to their later brothers and sisters, his conclusions did not lack assailants. The succeeding years have seen a good deal of work on the problem, the latest contribution being from Pearson himself.[1] Before its contents are considered, it may be of interest to recall Pearson's original contribution, which Schuster sums up as follows:

"The Crossley Sanatorium at Frodsham is filled with lower middle-class and working-class patients suffering from consumption, who come mostly from Manchester and, to a lesser degree, from Liverpool and its neighborhood. From the records kept of the family histories of the patients it is possible to tell how many came in each particular place in their families. It was then found that of 381 patients, 113 were first-born and 79 second-born. When the patients and all their brothers and sisters, living or dead, are taken together, it was found that in the 381 families there were 381 first-born and 366 second-born. Dividing these numbers by the average number of children per family, one arrives at the number of first-born and second-born which, according to the theory of probability, one would expect to find in a sample made up by picking one child at random from each family. The numbers are 67 and 64. The 381 sanatorium patients may be regarded as a sample selected by consumption, one from each family and among them the corresponding numbers are 113 and 79—that is to say, about 1¾ times as many first-born and 1¼ times as many second-born, as in the random sample of the same size. As the differences are too large to be due to chance, they appear to show that consumption does not pick at random, but selects more particularly the first-born and second-born. With regard to the third and later born members the differences were reversed, there being fewer of these among the patients than would be the expectation if the latter were drawn by chance, one from each family."

Pearson contented himself with presenting the statistics, not attempting to explain them. His critics attacked them from two sides—first on purely statistical grounds, and second, by attempting to explain them away. Pearson's new paper on the subject is devoted largely to refuting those of his critics who attacked him on purely statistical grounds; and into this aspect of the case the reviewer will not go. Those who are interested in the mathematical theories involved may consult the original paper. Pearson also sums up the evidence in support of his contention, however, and brings forward new data which equally tend to indicate that the first-born members of a population are weighted. It may be of interest to review this data.

DIVISION OF THE PROBLEM

There are, it is evident, several ways in which a statistically demonstrated

[1] On the Handicapping of the First-born, by Karl Pearson, F. R. S. With frontispiece and four diagrams, pp. 68, price two shillings net. University of London, Galton Laboratory for National Eugenics, Eugenics Lecture Series X. London, Dulau and Co. Ltd., 37 Soho Square, W., 1914.

handicap of the first-born might be made up, and it is important for the reader to keep in mind these differences. If there were a lot of one-child families in the population, and if this single child in each case were inferior, it is obvious that he or she would be listed as first-born in an enumeration, and the first-borns as a whole would get a black mark from the bad record of these one-child families; whereas it is conceivable that the first-borns in large families might at the same time be as good as or better than any of their brothers or sisters.

It is by such an explanation that some of Pearson's critics attacked his statistics from the Crossley sanitorium, as will be later explained.

On the other hand, it might be that the first-born in a family was inferior to his or her own brothers and sisters. To demonstrate this would obviously require a different line of statistical attack; and the meaning of the results, from a eugenic point of view, would likewise be distinctly different. Following Pearson's original contribution, many investigators have adopted this second method of attack altogether. The problem it involves is the more interesting and perhaps likewise the more important, but Pearson contends, and with apparent justice, that both problems are worthy of solution, and that the eugenist can not be content if the case is approached from either side alone.

In his new memoir he has worked out methods of analyzing his data from both points of view. Unfortunately his results are not easily followed in detail by a reader who lacks training in advanced statistical method. This is the more unfortunate, because in some instances a handicap is discernible by the one method of attack, but from the other viewpoint is found to be non-existent—thus in epilepsy, it appears that the greater number of first-born in asylums is due to the fact that they come from tainted stocks, and not to the fact that they are first-born.

This distinction must be kept in mind, whenever the problem of the first-born's handicap is studied, for without it an entirely erroneous result will be reached, a result likely to cause needless anguish to some of the large number of first-born children in the world.

DANGERS AT BIRTH

Before attacking the problem from the conventional side, Pearson notes the dangers which meet the first-born even at birth. Ansell has given the still-births per 1,000 born alive, in order of birth for 48,843 births; the rate for the first-born is 40, for the second-born 20, for the third-born 15.5, for the fourth to sixth 17.4 and for the seventh and over 20.9. "It will be seen that still-births for the first-born are *double* those of later births. And this disadvantage follows the first-born into the first year of life." The infantile mortality of the professional and upper classes for 48,843 births, likewise compiled by Ansell, shows that in the first year, per 1,000 born alive, the following numbers die:

First-born	82.2
Second-born	70
Third-born	69
Fourth to sixth	78.3
Seventh and over	97.4

Confirmatory data collected by the Galton Laboratory from the manufacturing towns of northern England are given. In Sheffield, "it is not till we get to the eight or ninth birth that the mortality is as great as for the first-born." The health of the children follows a similar course—it is not until the thirteenth child, in about 4,400 cases from Sheffield, that we find as much delicacy as in the first-born. This inferiority in health, of course, to some extent wears off with age, but it would still appear to be appreciable at twelve and thirteen, according to statistics quoted from school inspections.

Physical evidence of the defect of the first-born is also found in statistics as to the weights and lengths of 2,000 babies, made at Lambeth Lying-in Hospital. The first-born, both in boys and girls, weighs less and is shorter than the subsequent children, who in general increase regularly in these respects in accordance with their order of birth. There is some reason to believe that this increase is correlated to the increas-

ing age of the mother. "We have, however, distinctly guarded ourselves from any expression of the source of the inferiority of the first-born till the data, slowly accumulating, suffices to determine how much the first-born pays for the juvenility and how much for the inexperience of its parents.

"It will be seen from the totality of the above results that physically, in the early months of life, the first- or earlier-born babies are inferior to any babies before at least the seventh or eighth. We have now to ask whether this inferiority persists to later life, and whether it shows itself also in congenital defects."

CONGENITAL DEFECTS

Idiocy or imbecility is the first defect considered.[2] No matter in what way the data are analyzed, it appears that there is a distinct bias against the first-born.

Weeks' American data on epilepsy are next analyzed. "We must, I think, conclude by recognizing that, while there is a weighting of the elder-born even in epilepsy, this is due to a selection of families rather than to a selection of the elder-born in each individual family." In other words, the statistical observation that there are more first-born than later-born epileptics in an asylum is of no significance except when a large population is considered—it does not mean that in any given family the first-born is likely to be inferior in this respect to his or her successors.

The data for insanity are said not to have been available for such full analysis as were data of other defects. They appear to show that there is a weighting of the elder-born in the case of insanity, but they do not furnish grounds for saying that this may not be due merely to the fact that the subjects observed come of defective stocks.

Pedigrees of 952 albinos of European race are next examined. There is marked excess of albinos among the first-born: 241 cases instead of the 216 expected by the theory of probability; the second-born have no excess and the last-born seem to show a slight defect. "I think there cannot be the least doubt," Pearson concludes, "of a quite significant weighting of the first-born in the matter of albinism."

Criminality, on the basis of Dr. Goring's figures, seems equally to be a prerogative of the elder members of the family. When expected and observed distribution of criminals in families of each size is computed, "the actually observed first- and second-born criminals amount together to 717 as against 557 which would be anticipated if the tendency to crime were divided equally among all members. There is a defect of both intermediates and of last-born criminals. The general bias against the elder-born appears amply substantiated on these data."

Statistics for the tuberculous are next considered, in a much more refined way than was attempted when the first study was made. Even when each family is considered individually, it is found that there is a heavy preponderance of tuberculosis in the case of the first-borns, and a defect in the case of the late-borns.

Pedigrees of fifty families with congenital cataract are finally taken up, and here too "the less robust members of a tainted stock—and such are the first-born—appear more likely to be affected."

CRITICISMS NOT VALID

In conclusion, Pearson holds "that the criticisms raised against the handicapping of the first-born are not valid. The first-born is very significantly handicapped, and this statistical result will coincide with a good deal of personal and individual experience."

At the risk of tiresome repetition, it must once more be pointed out that when the problem is demonstrated by statistics, the handicap of the first-born might be of two kinds: it might be that the first-born in each family is actually inferior to the later-born, or it might be that the first-borns, as a whole, in the

[2] The type of feeblemindedness known as Mongolian is excluded from consideration, because it is already known to be associated with late births in large families. It is ordinarily attributed to "uterine exhaustion" of the mother.

population are an inferior group, because they come from inferior families. This point was particularly brought out by Dr. Alfred Ploetz of Munich, president of the International Society for Race Hygiene, in an address which he delivered before the First International Eugenics Congress (London, 1912). He said:

"Among the children of a number of marriages taken at random, there are a good many children of parents who died early, consequently there is a high proportion of children who represent early members in birth-rank, and principally first, second and third-born. Because of the death of one or both parents there could be no later born. First, second and third-born children therefore come in a far greater percentage from early deceased, that is on the average weaker parents, than do the later born, and they will therefore inherit in a higher degree the weaker constitution of their weaker parents."

"There is further another factor weighting small families," Pearson adds, "namely, they represent very frequently an exhausted virility in the parents. Certain types of parental degeneracy seem incapable of producing more than one or two children at most,[3] and the children of such parents are themselves feeble. But, if any small families are thus selected, we shall increase the number of early borns in the diseased population, for such small families have no late-borns."

Furthermore, he suggests "that the growth of the first child is hampered by conditions [physiological in the mother] which exist to a far less extent for the following births; but these conditions will be much harder for the first-born child when its mother is forty than when she is twenty-five. But the resulting family in the former case is likely to be far smaller than in the latter case. In other words, the handicapping of the first-born in small families may be increased by the addition of many small families in which the first-born is also late-born."

Thus general statistics on the weighting of the first-born must carefully distinguish whether it is actually the individual, or the family, that is weighted; and in this fact lies comfort for first-born members of healthy families.

Early critics appeared to think that the whole problem of the handicapping of the first-born might be explained away by this fact that in many cases it is the family, rather than the individual, which is handicapped. Pearson's first statistics of the tuberculous were indeed vulnerable on this ground, but his re-analysis of the data takes both these factors into account and appears to show that in many cases at least the first-born are handicapped altogether apart from the recognized weighting of small families.

EVIL OF SMALL FAMILIES

If this be the case, it seems evident that, from a biological point of view, and entirely apart from its effect on upsetting the selective birth rate, the small family is detrimental to race progress. That, says Pearson, "is the reason why I have approached this subject at all. After this lecture was delivered, I was asked by an anxious mother: 'Why, even if the doctrine be true, should it be published to the world as it would only alarm and so further injure a class of the community already asserted to be handicapped?' My reply to that question is: 'Study in the first place the incidence rates of these abnormalities we are discussing, and you will see that it is only in mass-statistics that the handicapping becomes sensible.' Further, I must add that in the science of National Eugenics we have to consider what profits the nation at large, and I feel strongly convinced that the present tendency (exhibited so markedly in France),[4] to make the first-born 50% instead of something less than 22% of the whole number of births, spells degeneracy. The individual feelings of the first-born,

[3] This does not necessarily contradict the generally well established principle that degenerate stocks are as a rule very fertile.

[4] The German birth-rate is notably high, but in Berlin the percentage of first-born in every 100 births had increased from eighteen in 1880 to thirty-three in 1906. The reader will recall that Cattell's statistics show American men of science almost habitually to have families of two children.

even if the handicapping were far more substantial than it is, cannot be considered to outweigh the national importance of the problem. If this principle of the handicapping of the first-born be true, as I have little doubt that it is—and if a similar principle holds for the last-born (to a lesser degree it is true) for some conditions like Mongolian imbecility—what must be the moral of the present lecture? Surely, that the better born are the intermediates in families from five to eight, and that when families are restricted to twos or threes, or extended to twelves and thirteens, there may be a quite appreciable tendency to increase the proportion of the less efficient in the community. I make no pretence at present to associate inferiority at beginning or end with too young parents or too old parents. I am only aware that we want much fuller data, so that we can correct for parental ages at marriage, and for period after marriage of the birth of each child. We want to study not only the order and number of children, but the interval between their births.

"The handicapping of the first-born is not, as some of my correspondents have supposed, subversive of any faith in heredity. It would not even be an argument against an hereditary Upper Chamber, except in so far as such a chamber is based on primogeniture. Statistics of the failure of the eldest-born of peers and of the success of their younger brothers might from this standpoint be of real interest.[5] The real argument against an hereditary chamber is the customary want of hereditary power in its members, *i. e.*, the neglect of the fact that a man has sixteen great-grandparents, and, possibly, only one of them may be of distinction—the man who won the title. As Galton wrote: 'An old peerage is a valueless title to natural gifts, except so far as it may have been furbished up by a succession of wise intermarriages. . . . I cannot think of any claim to respect, put forward in modern days, that is so entirely an imposture, as that made by a peer on the ground of descent, who has neither been nobly educated, nor has any eminent kinsman within three degrees.' The dearth of ability in the 'hereditary' peers of the present day is largely due to their neglecting marriage into able stocks, and in some cases quite possibly to a succession of eldest son inheritance—an evil which the whole community may bring upon itself, if it selects its surviving offspring in the same restricted manner. To criticize primogeniture is not to discard heredity."

[5] In "Hereditary Genius" Galton presented the following statistics concerning the relative birth-order of the eminent men whom he studied:

Only sons	11%
Eldest sons	17%
Second sons	38%
Third sons	22%
Later sons	12%

Hotel Accommodations at Berkeley

Acting on the advice of its California committee, the American Genetic Association has designated Hotel Claremont, Oakland, California, as official headquarters during its annual meeting, August 2-7. This hotel is just across the line from Berkeley, and has excellent transportation facilities to the university. It has accommodations for about 1,000 guests, prices being as follows:

Single room with bath, $3 per day ($1.50 if two persons occupy room).

Single room without bath, $1 per day; room for two without bath, $1 per person.

The secretary will be glad to make reservations for members of this association. It is highly important that these should be made as soon as possible.

The

Journal of Heredity

(Formerly the American Breeders' Magazine)

Vol. VI, No. 8 August, 1915

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The Journal of Heredity is published monthly by the American Genetic Association (formerly called the American Breeders' Association) for the benefit of its members. Canadian members who desire to receive it should send 25 cents a year, in addition to their regular membership dues of $2, because of additional postage on the magazine; foreign members pay 50 cents extra for the same reason. Subscription price to non-members, $2.00 a year, foreign postage extra; price of single copies, 25 cents.

Entered as second-class matter February 24, 1915, at the postoffice at Washington, D. C., under the act of August 24, 1912.

Date of issue of this number, July 26, 1915.

FRUITING BRANCH OF MANGOSTEEN

The glossy green leaves are not unlike those of the familiar rubber plant. The tree, like most trees in the tropics, retains its leaves throughout the year. Photograph from a water color sketch by Miss D. G. Passmore. (Frontispiece.)

THE MANGOSTEEN

"Queen of Fruits" Now Almost Confined to Malayan Archipelago, But Can Be Acclimated in Many Parts of Tropics—Experiments in America—Desirability of Widespread Cultivation.

DAVID FAIRCHILD

Agricultural Explorer in Charge, Office of Foreign Seed and Plant Introduction, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

ONE of the first questions which a traveller in the Malay Archipelago may expect old residents to ask him, is, "Have you eaten a mangosteen?" If he has not, he may then expect to hear an enthusiastic description, more or less vague, of the deliciousness of what has justly been called the "queen of fruits."

It is a mistake to think that you have only to cross the line into the oriental tropics to have bunches and basketfuls of this fruit offered to you at the ridiculously low price of Eastern Shore peaches in the height of the season. Outside of the Straits Settlements, Java, Sumatra and the Moluccas the fruit is a rare one and as much sought after by the resident of the country as it is by the visitor.

It is not difficult for one who has tasted it to understand why the mangosteen is such a general favorite, although to give someone else an idea of its qualities is by no means an easy task.

There are many people who never acquire a taste for any of the fruits of the tropics. The Prussian finds them insipid in comparison with his plums and prunes, and the wall peaches of Kent are considered by the English as immeasurably superior. Tropical fruits are often stigmatized as insipid, resinous, mawkish, or too sweet. There are, it is true, many which are open to these objections, but it must be remembered that most of the fruits of the tropical zone are ungrafted seedlings analagous to our wild apples; and the wonder is that they prove as good as they do.

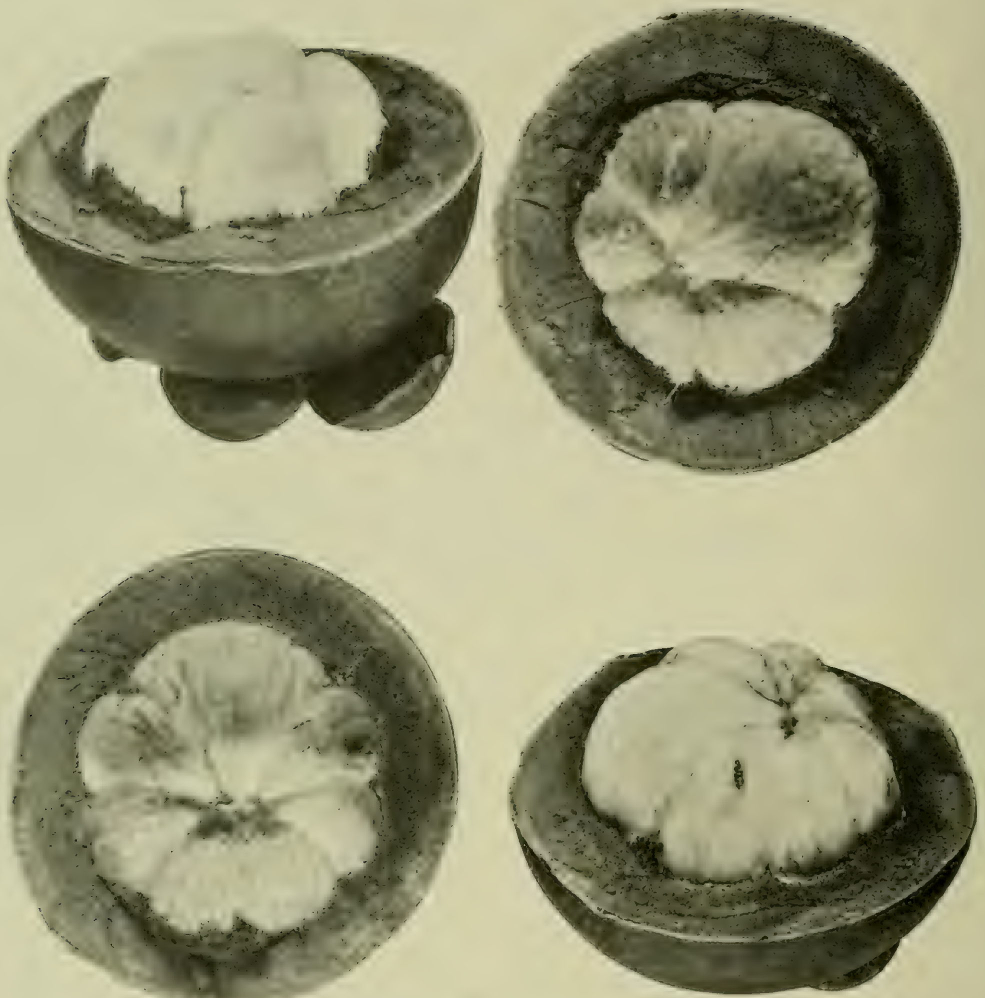
MANGOSTEEN UNIQUE

The mangosteen, however, though belonging to the category of a strictly tropical fruit, is so different from the majority of them as to deserve the special place accorded to it by all who have ever tasted its snowy white pulp. It outranks in delicacy, if not all other fruits in the world, certainly all others of the tropical zone,[1] and it is a joy to the eye as well as to the palate to feast on mangosteens.

This delicious fruit is about the size of a mandarin orange, round and slightly flattened at each end, with a smooth, thick rind, rich red-purple in color, with here and there a bright, hardened drop of the yellow juice which marks some injury to the rind when it was young. As these mangosteens are sold in the Dutch East Indies—heaped up on fruit baskets, or made into long, regular bunches with thin strips of braided bamboo,—they are as strikingly handsome as anything of the kind could well be, but it is only when the fruit is opened that its real beauty is seen. The rind is thick and tough, and to get at the pulp inside requires a circular cut with a sharp knife to lift the top half off like a cap, exposing the white segments, five, six

[1] This has been recognized by travelers in the East from the very earliest times. Jacobus Bontius, in his Hist. Nat. et Medic. Indiae Orientalis, VI, 28, 115 (pub. in 1631), wrote enthusiastically:

> Cedant Hesperii longe hinc, mala aurea, fructus,
> Ambrosiâ pascit Mangostan et nectare divos—
> Inter omnes Indiae fructus longe sapidissimus.



FRUITS OF THE MANGOSTEEN

One of the admirable qualities of the mangosteen is the beauty of its fruit. The thick, corky, outer shell, when cut, is of a delicate pink, rapidly deepening to crimson on exposure to the air. The segments of flesh inside are of an ivory tint. The heavy outer shell is a distinct commercial advantage, in protecting the fruit from bruises, during shipment. Photograph natural size. (Fig. 1.)

or seven in number, lying loose in the cup. The cut surface of the rind is of a most delicate pink color and is studded with small yellow points formed by the drops of exuding juice. As you lift out of this cup, one by one, the delicate segments, which are the size and shape of those of a mandarin orange, the light pink sides of the cup and the veins of white and yellow embedded in it are visible. The separate segments are between snow white and ivory in color and are covered with a delicate network of fibers, while the side of each segment where it presses against its neighbor is translucent and slightly tinged with pale green. As one poises the dainty bit of snowy fruit on his fork, and looks at the empty pink cup from which it has been taken, he hardly knows whether the delicate flavor or the beautiful coloring of the fruit pleases him the more, and he invariably stops to admire the rapidly deepening color of the cut

rind as it changes on exposure to the air from light pink to deep brown.

The texture of the mangosteen pulp much resembles that of a well-ripened plum, only it is so delicate that it melts in your mouth like a bit of ice cream. The flavor is quite indescribably delicious, and resembles nothing you know of; and yet reminds you, with a long after taste, of all sorts of creams and ices. There is nothing to mar the perfection of this fruit, unless it be that the juice from the rind forms an indelible stain on a white napkin. Even the seeds are partly or wholly lacking and when present, are so thin and small that they are really no trouble to get rid of. Where cheap and abundant, as in Java, one eats these fruits by the half peck and is never tired of them; they produce no feeling of satiety, such as the banana and the mango do, for there is little substance to the delicate pulp.

MAY BE DISSEMINATED

The tree which bears this fruit was once supposed to be able to live nowhere outside of the Malay region. It has in recent years, however, shown itself capable of acclimatization in many tropical regions remote from its original home, and it has even fruited in the unnatural conditions of an English greenhouse.

The mangosteen is no way related to the mango as it is sometimes thought to be from its name. Its foliage is of an even richer dark green than that of the orange, and its individual leaves are not wholly unlike those of the rubber plant, though, as a rule, smaller. The regular, rounded crown is strikingly characteristic and there are no more beautiful fruit trees in the tropics than the mangosteens. It has probably been in cultivation for centuries among the fruit-loving inhabitants of Java and Malacca, although the absence of any distinct varieties would seem to indicate the contrary. Perhaps in its wild state it was so nearly perfect that no attempts to improve it have ever been made.

Such a fruit seems almost to have been "born to blush unseen" for those parts of the world in which it grows are, as a rule, populated by half civilized races, who do not fully appreciate its extraordinary qualities. Had it been within easy reach of some great metropolis of white people, there would have been millions of dollars invested in its culture and thousands of acres planted with the beautiful trees.

The most delicious fruit in the tropics is surely worth the careful consideration of any government which owns territory suitable for its culture that is within easy reach by steamer of a big home market. The United States, since its acquisition of Porto Rico and the Canal Zone, is now in this position and the possibilities of the establishment of this fruit as an industry deserve to be thoroughly investigated. Trials of an extensive character should be carefully worked out, large numbers of plants ought to be started in different localities, and the intelligent attention of experts be given it. The establishment of the mangosteen as a minor industry in our tropical dependencies, should it prove a possibility, would be of very important commercial advantage to the inhabitants and would put within reach of our fruit-eating public, one of the greatest delicacies in the world.

SHIPPING QUALITIES GOOD

Although it is a very delicate fruit, its pulp is protected by an extremely hard, tough rind which makes it a tolerably good shipper. Quantities have been sent from Singapore to Ceylon and even to Shanghai and Japan, over eleven days by boat. The head steward of a Dutch vessel in the Malay Archipelago once informed me that he had carried mangosteen fruits for twenty-five days without their decaying, but that they must not be exposed to the sea air; and he was of the firm belief that they carried best in a dry, warm, close place, but decayed rapidly if given too much air or if put on ice. The decaying mangosteen hardens its rind, which is a distinct advantage, and makes continual sortings for fear of contamination unnecessary, as well as the immediate detection of a decayed fruit a very easy matter. According to Dr. I. N. Ridley,

MANGOSTEEN TREE IN LOMBOK, DUTCH EAST INDIES

The tree likes a large amount of water about its roots, but this water must not be stagnant. Most of the failures in cultivation appear to be due to overlooking this requirement. If it is properly attended to, the mangosteen will endure a considerable variety of soils and climates, and experiments made during the last generation leave no doubt as to the possibility of its acclimatization in various parts of the American tropics. Photograph by Fairchild. (Fig. 2.)

formerly superintendent of the Botanic Gardens of Singapore, the drops of yellow gamboge which sometimes form inside the fruit are not, as has been supposed, caused by a disease, but are the direct result of external bruises. A heavy storm may sometimes so knock the nearly mature fruits about that the majority will be worthless. Any very rough handling during the plucking may bring about the same result.

A more or less careful study of the question in Java, the Strait Settlements and Ceylon has convinced the writer that the acclimatization of the mangosteen on the island of Porto Rico, and in many other parts of tropical America, is a possibility and that the principal difficulties of its culture have probably arisen from an ignorance of the soil conditions demanded by the plant.

In Java, so far as the writer is aware, there are scarcely any commercial orchards of the mangosteen, every land owner having a few trees in his yard; in fact, the orchard method of cultivating fruits is, as a rule, little understood, or pays too poorly, to be followed in the tropics. Scattered trees through the native villages supply all the demands of the market.

EXPERIENCE AT SINGAPORE

In Singapore there are some small mangosteen orchards, that is, mango-

steens mixed with other fruits. One which is easily accessible lies on the well-known road to the Botanic Gardens, some 2 miles from Raffles Hotel. The land is low and wet and several drainage canals cut it up into large, square blocks. The soil is a clay and evidently saturated with moisture. About each tree is a circular bit of cultivated soil the rest being in grass, and scattered over the bare soil under the trees is a mulch of leaves and coconut husks. I do not know how old the orchard is, but it is presumably about 30 years of age. At this season, January, no sign of a bloom or fruit was to be seen. Dr. Ridley, then director of the Botanic Gardens in Singapore, remarked that though apparently in excellent condition this orchard was not productive. It was his belief that it needed pruning and his experience with a tree in Government House Gardens bears out his belief. He cut out the innermost branches from one of the lot of old mangosteen trees there, which had not borne well for years, and as a consequence it produced, the next year, an abundance of fruit.

His opinion is that the trees should be regularly pruned of all the small inner branches.

In Ceylon, where the species was introduced from the Straits Settlements about 1800, it is still a rare plant. This is the history of most fruits demanding certain special conditions in the tropics and, when one is told by those who should know that the natives of one part of Ceylon do not even know what the bread fruit is, although it forms a staple food plant in other sections of the same island, he ceases to wonder that even so remarkable a fruit as the mangosteen should be a rarity a century after its introduction.

The introduction of the mangosteen into Saigon about a century ago was more successfully done and it is interesting to note that the fruit was first brought from Penang by a noted Bishop, Father D'Adran. There are said to be at Lai Thiou, not far from the city of Saigon, what are probably the largest mangosteen orchards in the world, comprising 300 to 400 trees, and Dr. Haffner, formerly director of Agriculture of Cochin China, says that in the season the fruit from this orchard is sold for about two dollars gold a thousand, which price cannot be called high when compared with what they bring in Ceylon.

The popular idea that it is a difficult tree to cultivate has undoubtedly prevented many in Ceylon from trying it, and the secret of its successful cultivation seems even yet to be understood by only a few men in the island. To W. H. Wright, of Mirigama, the writer is indebted for full particulars of the culture of the mangosteen, with which Mr. Wright has been one of the most successful of all the men in Ceylon who have attempted to grow the plant.

SUCCESS IN CEYLON

His orchard consisted, at the time of my visit in 1902, of 23 trees and was then probably the largest in the colony. It was from 8 to 10 years old, having been planted out with young 2-year-old trees which were sent him as a present from the Malay Peninsula. The selection of a site for his orchard was a very happy one; a moist spot in his coconut plantation, a part of which had at one time been used as a rice field. The ground was so moist that open drains were cut through it to carry off the superfluous water and these are still kept in order. The soil of the squares on which the trees are growing is so moist and soft that, were it not for a layer of coconut husks, one's feet would sink in up to the ankle as he walks across them. The roots, under these circumstances, are bathed continually in fresh, not stagnant, moisture. Mr. Wright attributes his success in growing mangosteens to the fact that he has planted them on soil that never dries out but has, at a few feet from the surface, a continual supply of fresh moisture. The water in his well near by is six feet from the surface of the ground. H. L. Daniel, who has been for fifteen years trying to grow this fruit, and who, during that time, has planted over a hundred young trees, assures me that this is one of the secrets of the culture of this difficult fruit, and

gives Mr. Wright the credit for first finding it out.

Another important detail relates to the matter of transplanting the young seedlings. Mr. Daniel plants the seeds[2] in a small pot or in a coconut husk, and keeps them well watered and slightly shaded with a coarse matting of coconut leaves. He transplants from this small pot to a larger one when the roots have filled it; and in removing he cuts off the top root if the latter is exposed. For two years these young plants are kept in the pots and grow to a height of 2 to 2½ feet. It is useless to transplant them before they are at least 2 feet high, for the check given them, if too young, by the transplanting is so great that they refuse to grow, or, to use Mr. Daniel's expression, "they only croak."

SHADE IS NECESSARY

When transplanted, the plants are set in a hole 3 feet cube in size. Stiff soil is best but not absolutely necessary, as they will grow in light soil if the subsoil is a good paddy mud. From the first the young trees should be shaded with a matting of coconut leaves, which is suspended 2 feet or so above the top of the plant. This is to prevent the wilting and subsequent death of the two red, partly developed leaves, which first appear from the seed, and which must be kept alive if the plant is to make a rapid growth. If these precautions of potting, shading, and selection of soil are followed, trees should come into bearing seven years from seed, producing a small crop of a hundred fruits or so. The subsequent treatment of the mangosteen orchard seems to be very simple,—no pruning of any kind is commonly practiced, although it might be advisable to prune; and little cultivating is done. A mulching of coconut husks about the base of the tree to keep the surface soil continually moist, and the application of a small amount of earth from the poultry yard sprinkled about underneath the trees each year, are the only attentions given them. Whether or not artificial fertilizers could be employed with profitable effect is a question that has not been answered.

Favored with the conditions described, the trees on Mr. Wright's place have done remarkably well. They produce two crops of fruit a year: the first ripening in January, being from blooms produced in August, is a small one, not more than 100 fruits to each tree, while the second, from flowers produced in January or February, is a large one and matures in July and August. Mr. Wright estimates that each tree of his orchard produces from 600 to 800 fruits a year, counting both crops, and he has been selling these for six to nine rupees ($1.98 to $2.97) a hundred, making his gross receipts, figured on the lowest price, $11 to $15 per tree. The work of picking, packing and transporting to the railway station, although repeated every other day, is not expensive in a land where laborers earn only 12 to 16 cents a day. There can be no question that such an orchard pays well even in Ceylon, where the fruits are sold for from 2 to 3 cents apiece. What the profits would be if they were sold for such fancy prices as would be offered by the fruiterers of any big metropolis can be easily imagined.

AMERICAN POSSIBILITIES

There are many essential questions to be considered in connection with the introduction and establishment of the mangosteen industry in Porto Rico, Hawaii or Cuba, or in America generally.

The possibility of the plants living outside of their own home has been abundantly demonstrated. Trees are growing and have fruited well in Trinidad and Jamaica in the West Indies. Specimens have even been shipped from there to London. In the Territory of Hawaii, on the Islands of Kauai and

[2] The fruit is technically a berry, containing many ovules or seeds; but most of these in each fruit are aborted, for which reason it is difficult to get mature, well-developed seeds from good strains of the mangosteen. The pulp which is eaten is technically an aril, an extra coat that is developed in the same way as the original integuments are. The abortion of the ovule does not interfere with the growth of this aril.

ORIENTAL VENDOR OF MANGOSTEENS

The fruits are seen piled up in the basket on the left-hand side; among them are the fruits of the rambutan, *Nephelium lappaceum*, covered with long, fleshy protuberances while a small tray contains the fruits of the Doekoe (*Lansium domesticum*), an interesting fruit which is known in the Philippines as the "lanzon." The rambutan is closely related to the licher (*Litchi chinensis*), a fruit with which every traveler in South China is probably familiar. (Fig. 3.)

Maui, mangosteen trees fruit regularly, bearing good sized specimens of excellent flavor. Francis Gay, who planted the tree at Makaweli, Kauai, wrote that where the tree is growing the water is about 6 feet below the surface of the soil, that the tree is irrigated twice or three times a month, and that the rainfall of the region is 6 to 7 inches a year. This tree of Mr. Gay's is about 25 years old, fruited first when 10 years old and now bears only a few fruits per year; which latter very from 2½ to 3 inches in diameter. It stands about 15 feet above sea level in a spot well protected from the winds by windbreaks and is growing on a sandy, alluvial soil. Mr. Gay finds that only a small proportion of the young plants set out, live, the most of them dying the first year, but whether proper protection was given to the tender leaves of these young plants or not he does not state.

Dr. J. C. Willis, formerly director of the Botanic Gardens in Ceylon, assured me that trees grew well in the Gardens at Burliar in the Nilgiri Hills in the Madras Presidency of India. There are a number of trees in the Sulu archipelago of the Philippines, and even in islands much farther north, and fruit is shipped to Manila in the season. The mangosteen has even been brought into fruit under the grey

skies of England in the conservatory of the Duke of Northumberland, at Syon near Kew, as far back as 1854.

In Florida and California the mangosteen has been tried on numerous occasions, but without success. It is not likely that it will ever prove adaptable to the continental United States.

In Porto Rico it is not reported ever to have fruited—due merely to the fact, I believe, that it has not been adequately tried. In Cuba a number of trees have been planted, and some of them are flourishing; none of them has yet borne fruit. That they will under proper conditions stand a very high rainfall is evident from the climatic records of the country of their origin. Further, a tree 30 years old has long been bearing fruit at St. Aroment, Dominica, B. W. I., 400 feet above sea level, where the average annual rainfall is 105 inches; and at the Point Mulâtre estate in the same island are a dozen healthy trees, growing in rich valley soil under an average annual rainfall of 150 inches. No report is available on the fruiting of the latter trees.

FLOURISHES IN CANAL ZONE

The tree was introduced to the Canal Zone nine years ago, in a rather interesting way. Dr. W. W. Keene of Philadelphia, traveling in Malaya, ate the fruit, admired it and wrote to the Secretary of Agriculture in Washington asking whether it could not be introduced to the Canal Zone. The Secretary referred the matter to me, and I took it up with Col. Gorgas. After investigating the possibilities, the canal authorities finally decided to take up the introduction of new plants that promised to be of commercial value, and established an experimental garden. Among the first things I sent them were some mangosteens. They gave promise of being a complete success, but the experimental garden was unfortunately discontinued before any definite results had been realized. Lately the work has been taken up again, and I confidently expect to see the mangosteen fruiting in the Canal Zone.

There certainly can be no question, that the plant is amenable to acclimatization, and where the proper physical soil conditions are given it, which conditions seem to have been generally misunderstood, there is no reason why this plant should not be as common throughout the tropics of the Western Hemisphere as it is in the Malay region. Roxburgh's complaint that he could not get plants to grow anywhere in India has done much injury by discouraging attempts to cultivate it and loses force in the face of similar unjustified complaints formerly made in Ceylon where now there are successful orchards under cultivation.

RELATIVES OF THE MANGOSTEEN

There are several species of the big genus to which the mangosteen belongs that deserve attention as possible stocks upon which to graft the latter advantageously. The only record I have found of any attempts being made in the tropics to graft the mangosteen is that in Woodrow's Gardening in India, p. 173, where he states that he grafted one upon a related species of Garcinia (*G. indica*) at the request of a Revenue Commissioner at Rutnagberry, where 104 inches of rain fall in a year and the average temperature is 78. Unfortunately, nothing is said as to the success of this effort. Trials made at the Peradeniya Gardens, in Ceylon, to graft it upon another nearly related species, *Garcinia xanthochymus*, met with little success. This, however, does not signify that any unsurmountable difficulty would be encountered if the most careful methods of grafting which are in vogue in temperate regions were employed, or if even a sufficiently large number of trials were made.

The *Garcinia xanthochymus* is a rapid grower, abundant seed producer, and easy of cultivation, and might prove most valuable as a stock. If not, however, there are a couple of hundred other species which should be tested, some of them with edible fruits and others suited to dry hilly situations.

By using the old method of inarching, or "grafting by approach," G. W. Oliver of the U. S. Department of Agriculture was able to get altogether satisfactory results in working the mangosteen on twenty other species of the genus

Garcinia.[3] Of these, he says, "only a few can be recommended as promising stock plants. . . . The most promising species of Garcinia for use as stock plants for the mangosteen are *Garcinia tinctoria*, *G. morella* and *G. livingstonei*, in the order named, the last a native of Portuguese East Africa. The two first named are from the Malay Peninsula. . . . All the promising species ought to be tried whenever there is an opportunity. Some species of Garcinia lately found in the Philippine Islands would seem to be especially promising mangosteen stocks, especially those said to grow under widely varying conditions.

STOCKS EASILY GROWN

"None of the species of Garcinia used as stocks are difficult to raise from seeds, provided they are fresh. They are easiest to germinate when sown in soil composed largely of partially decomposed leaves mixed with a little loam and rough-grained sand. They should be potted as soon as the first leaves are well developed. All the Garcinias with the exception of *G. mangostana* have magnificent root systems, and they thrive under ordinary treatment in so far as soil watering and a considerable range of temperature are concerned."

Dr. Ridley, of Singapore, says the seashore mangosteen, *G. hombroniana*, is a species which he has long wished to cross with the true mangosteen. It has fruits with a delicate peach flavor and white flowers, and crosses between the two species might prove more rapid growers and better producers or make good stocks for the true mangosteen. In Cochin China there are at least ten species of *Garcinia*, three of which are edible, *G. cochin-chinensis*, *G. loureiri*, and *G. indica*, according to L. Pierre in his *La Flore Forestière de la Cochin Chine*. Specimens of several of these are now growing in the Botanic Gardens of Saigon and the late Dr. Haffner expressed a willingness to secure seeds for experimenters.

The whole subject of suitable stocks and improved methods of propagation of the mangosteen, deserves to be given a study in connection with its introduction into America. There are forty-two genera and 450 species belonging to the mangosteen's family (*Guttiferae*), many of which deserve investigation as mangosteen stocks. Mr. Oliver worked with two of these allied genera,—Calophyllum, which did not yield good unions, and *Platonia insignis*, which he says is "a very promising stock from one to three years after germination, and if it will grow under conditions suitable for the mangosteen, it may turn out to be the best stock of all those tried."

Especial effort should be, and to a certain extent is now being, made to find hardy stocks that will permit the propagation of the mangosteen in less strictly tropical regions than those to which it is now confined. It is possible that hybridization of some of these species would produce vigorous, resistant stocks that would be of great value. Here as everywhere among tropical fruits, the plant breeder faces opportunities of almost illimitable promise, and a field that has hardly been touched.

It is not likely that much is to be expected from direct hybridization of the mangosteen. It is already so far superior to its congeners, that hybrids could hardly fail to be worse, rather than better, than the parent, as far as quality is concerned. There is, however, ample room for selection, and isolation of the best strains, which may then be propagated under varietal names.

A thorough experimental study of the subject would doubtless show other possibilities that can not now be seen. At present, however, it is perfectly safe to say that there is no obstacle to the dissemination of this queen of tropical fruits, throughout the warmest parts of the American continent; and that if it can be grown on a commercial scale within easy shipping distance of Unites Stated markets, the connoisseurs of this country will have added to their menu a fruit which has been long acknowledged by many as the most delicate flavored fruit in the world.

[3] See Oliver, G. W., "The Seedling-Inarch and Nurse-Plant Methods of Propagation." U. S. Dept. of Agr., B. P. I., Bull. No. 202, Washington, D. C., 1911. Valuable details in regard to the growth of seedlings as well as propagation by grafting are given in this publication.

Physical Conformation of Cows and Milk Yield

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In a quotation from the Board of Agriculture on conformation of cows and milk yield which recently appeared in the Journal of Heredity, (p. 253, June, 1915) it is pointed out that so far as the studies of J. Reimers go, they show that there is no correlation between physical conformation and milk yield.

The results (at least as far as relationships close enough to have any practical significance for purposes of predicting yield from conformation are concerned) are quite what those who have an extensive first hand acquaintance with biometric work would have expected.

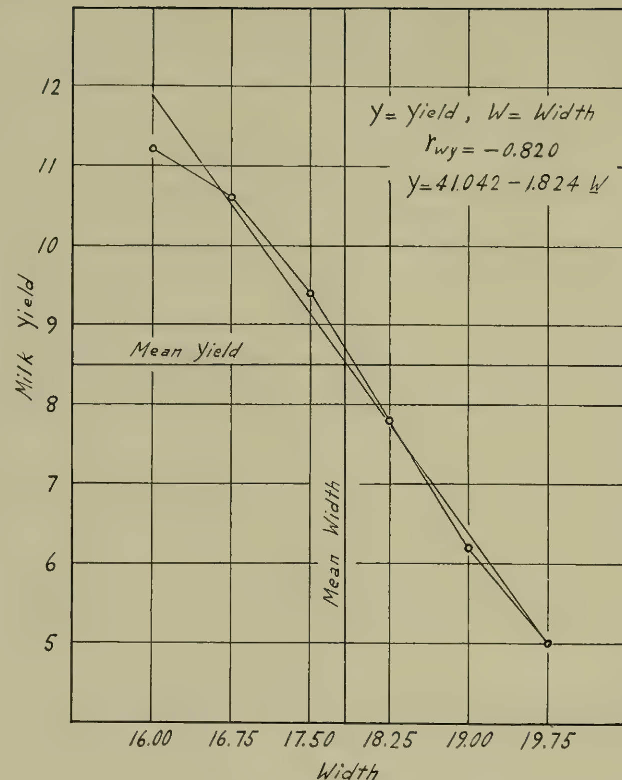
The purpose of this note is to call attention to and suggest an explanation for an anomalous series of data of this kind. G. Korreng has recently expressed the conviction (Jahrbuch für wissenschaftliche und praktische Tierzucht, vol. VII, pp. 132-142, 1912) that there is an intimate *negative* relationship between width of nether jaw, "Ganaschenweite," and milk yield — animals with the narrower jaws being the best milkers. In substantiation of his views he gives a series of 112 measurements and yields, which actually show a strong negative correlation between width and yield. The frequency of individuals having various widths and yields is shown in the accompanying table, which has been drawn up from his data.

In Figure 4, I have plotted out the mean yields for animals of different widths. They *decrease* with great regularity as width increases, as is shown by the straight line fitted to the data. Apparently, therefore, the data fully substantiate the contention that there is a relationship between conformation and milk yield so close as to be of practical value in selecting the best milkers.

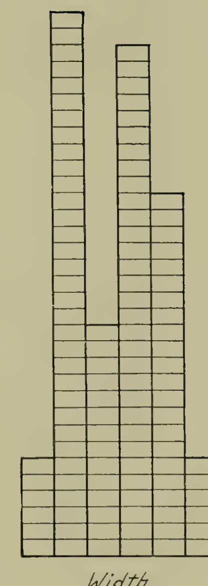
If, however, one carries the analyses of the records a step farther than Korreng has done, and examines the frequency distributions for the characters under consideration as shown in the totals of the table, and represented in Figures 5 and 6, he sees at once that both are distinctly bimodal. This is particularly conspicuous in the case of width. The two-humped condition is not so pronounced in the case of milk yield, but is nevertheless probably significant. These conditions suggest that Korreng's measurements were taken on a group of animals that are not racially homogeneous. A mixture of heavy beef cattle giving a low milk yield and light built dairy cattle would

MILK YIELD IN LITERS

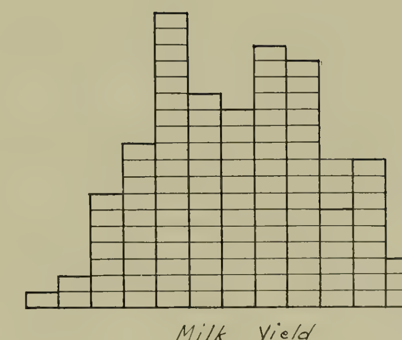
Width of Jaw in Centimeters	2.8 to 3.6	3.7 to 4.5	4.6 to 5.4	5.5 to 6.3	6.4 to 7.2	7.3 to 8.1	8.2 to 9.0	9.1 to 9.9	10.0 to 10.8	10.9 to 11.7	11.8 to 12.6	12.7 to 13.1	Totals
15.75–16.25	....	....	....	....	....	....	1	....	1	1	3	....	6
16.50–17.00	....	....	....	....	1	3	1	5	9	5	6	3	33
17.25–17.75	....	....	....	....	1	1	2	5	5	....	....	....	14
18.00–18.50	....	....	....	4	6	8	7	6	....	....	....	....	31
18.75–19.25	1	1	3	5	10	1	1	....	....	....	....	....	22
19.50–20.00	....	1	4	1	....	....	....	....	....	....	....	....	6
Totals....	1	2	7	10	18	13	12	16	15	6	9	3	112



(Fig. 4)



(Fig. 5)



(Fig. 6)

EXPOSING A FALLACY IN A CORRELATION

Measurements of the relation between width of lower jaw and milk yield of 122 cows satisfied the German professor G. Korreng that there was a negative correlation of .82 between them. This fact is shown in Fig. 4 above. If it were reliable, it is evident that by picking out cows with narrow jaws, we would get cows which were good milkers. When we go behind the returns, however, and examine the frequency distributions, as Mr. Harris has done in Figs. 5 and 6 above, we find that in each case where we expect to see a fairly smooth curve, we get a two-humped figure. This leads us to suspect that Korreng had two different kinds of cattle in the material he studied—for instance, a mixture of heavy beef cattle giving a low milk yield, and light dairy cattle. On a mixed group of this sort, it is evident that correlations are not of great value to the breeder. Nevertheless, the correlation found by Korreng is so high that it is of much interest, and should be tested by American dairymen.

theoretically give just such a result as this. Biometricians have frequently warned against the dangers of just such spurious correlations as this. Everyone knows that races of cattle differ in physical dimensions and in milking capacity.

What is really needed is a means of predicting yield from more readily measured characters *within a pure race.* Korreng's data are certainly not convincing in this regard.[1]

Nevertheless it must be admitted that here is a set of measurements which show a far more intimate relationship with milk yield than is generally found. The explanation suggested in this note may not be the correct one at all. Until such cases as the present are fully cleared up by those who have the necessary biological facilities the problem of the relationship between bodily conformation and milk yield cannot be considered finally solved.

[1] Korreng states explicitly that he used the greatest care in the selection of his animals. If they are really racially homogeneous the frequency distributions are very unusual. The only other explanations that I can suggest are that the bimodal condition is due to random sampling merely, or that personal equation played a part in the making of the measurements.

Milk Indications

For many years breeders have sought to find something in the appearance of a cow which would indicate whether or not she would yield much milk. Kronacher and Schmidt suggested that an animal with slender, delicate bones and horns would prove the best milker, and Laurer in 1910 presented measurements to prove this. He further attempted to show that there was a correlation in the growth of these parts: the finer the skeleton, the finer the horns, and conversely that large horns were always associated with a large skeleton. The numbers which he used were inadequate, so Dr. Max Müller and K. Narabe, of the Imperial Japanese University of Tohoku, have continued the investigation with 136 cows of different breeds, reporting their conclusions in the Landwirtschaftliche Jahrbuch, XLVI, 1, Berlin, 1914. They decide that the growth of bones and horns is closely related, and that the animals with small skeletons or delicate horns are the best milkers. Such "milk indications" have been reported many times in many countries during the last half century, and the breeder should take them all with a grain of salt, but it may prove of interest to some of the members of this association to test the theory in their own herds.

Crossing of Wheat Flowers Unprotected After Emasculation.

During the summer of 1911, 140 Turkey Red winter wheat flowers were emasculated. These flowers were on seven heads, each head containing twenty flowers. Two flowers, the first and second, were left in each spikelet, the upper flowers being removed by pinching off the rachilla above the second flower. Five spikelets were left on either side of the rachis, making a total of ten spikelets for each head. The spikelets left were the lower ones of the head, the upper spikelets being removed by cutting off the rachis above the tenth spikelet. The remaining flowers of the ten spikelets were emasculated in the usual way. The flowers were not artificially pollinated and the heads were not covered or protected in any way. At the end of the season the heads were harvested, the grains from each head being threshed out and counted. It was found that out of the total of 140 flowers emasculated, 112, or 80% had set seed.

It has been the writer's practice always to cover and protect the heads worked with after emasculation and after pollination to avoid the possibility of foreign pollen pollinating the stigma before the desired pollen was applied artificially and fertilization had resulted. This test was made for the purpose of determining whether there is any possibility of the emasculated flower becoming pollinated if left unprotected before pollination. Simultaneous with this trial another was made, in which a number of flowers were emasculated and were covered but were not pollinated. When these heads were harvested, it was found that less than 1% of the flowers had set seed, the small number of seeds produced apparently being the result of faulty emasculation, in which the stigmas became fertilized in removing the stamens from the flowers.

D. W. Frear,
Colorado Agricultural College.

SINGLE-GERM BEET SEED

Sugar Beet Is Being Made to Produce Single-germ Seeds Instead of Multiple-germ Seed Balls—Labor Thus Saved Will Mean Gain of Several Million Dollars Annually to Industry.

C. O. Townsend

Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

THE effort to produce a strain of sugar beets that will bear only separate seed germs, instead of the seedballs containing several germs, which ordinarily characterize the sugar beet, arose from a desire to reduce the cost of producing sugar beets and beet-sugar.

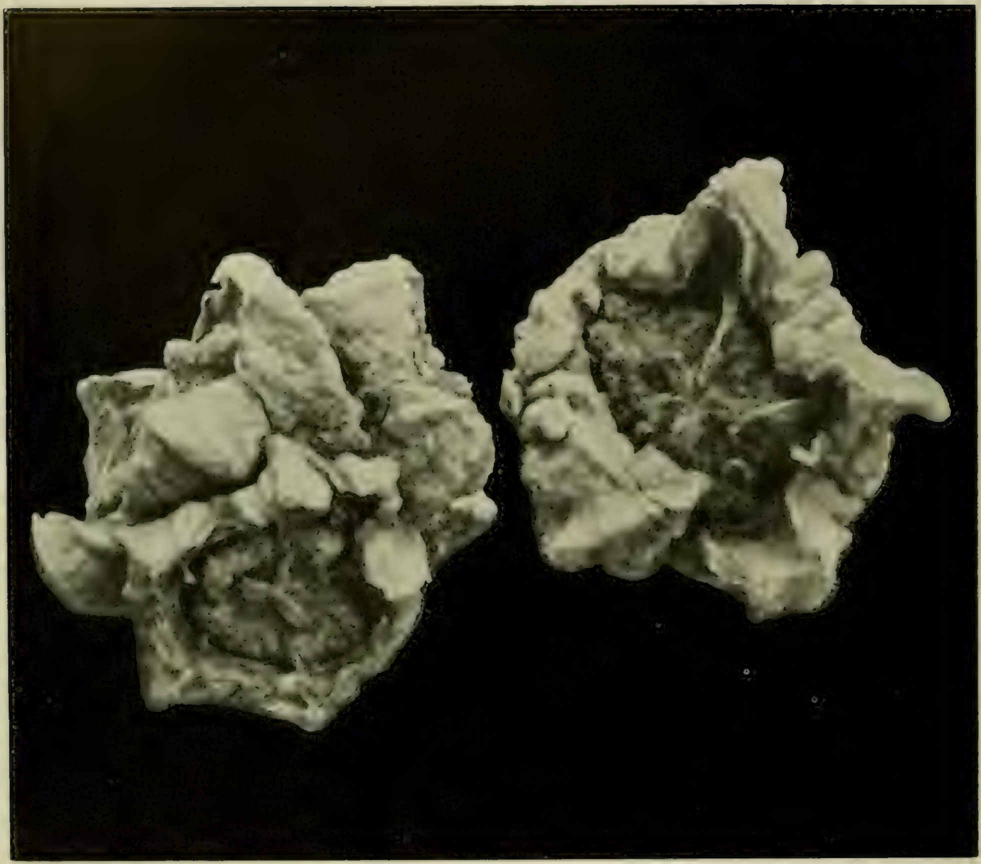
The term "seed ball," as applied to beet seeds, implies a combination of seeds into a mass having a more or less rounded appearance. Each germ arises from a single flower, and when they are in clusters of two or more, as is usually the case, a multiple-germ seed arises; whereas if the flower stands by itself on the stem, a single-germ seed results. If two or more single flowers stand very close together but do not arise from the same point as in the case of the flower clusters, each will produce a single-germ seed. Even if the flowers are so close together that the seeds slightly adhere in the process of development, they are easily separated and readily distinguished as single-germ seeds. It appears, therefore, that the arrangement and distribution of the flowers on the seed stalk determine whether the seeds are to be single-germ seeds or whether they are to be parts of multiple-seed balls. One can determine in practically all cases, even before the flower and buds are open, whether they will produce single-germ seeds or whether they will be parts of a multiple-seed ball.

More than 95 per cent. of the beet seed of commerce is composed of multiple-germ seed balls, the germs of which are so closely welded together by nature that they cannot by any known means be separated without injury to the germ. In other words, less than 5 per cent. of the seed balls of commercial beet seed consist of a single germ. The number of germs in the remaining 95 per cent. or more of seed balls varies from two to seven germs per ball. Hence the number of germs produced normally as single-germs, that is, not welded into combination with other germs, does not exceed 1 per cent. of the total number of germs produced by any commercial seed-producing plant that has come under the observation of the writer.

METHOD OF PROCEDURE

The fact that almost every beet seed plant that matures seed produces a few one-germ seeds shows that we did not create anything new by our work, despite a popular belief to the contrary. We simply took advantage of a tendency to produce single germs, and selected with a view to getting an increase in this tendency. Our goal is the production of a strain of sugar beets which will yield only one-germ seeds.

The principal value of such a strain lies in the economy of labor it would make possible. It is an established fact that the best results in beet growing are produced when each beet plant stands alone and 8 inches or more from every other beet plant. Remembering the construction or make-up of commercial beet seed, it is apparent that the only way to have each beet stand by itself, so long as multiple-germ seed balls are planted, is to pull out by hand all beets but one at regular intervals in row. This is called hand thinning and is the most expensive and laborious single operation in sugar beet growing, costing from $5 to $8 per acre, or



SINGLE-GERM AND MULTIPLE-GERM BEET SEEDS

The seedball at the left is made up of four seeds or germs welded together so closely that they cannot be separated without injury. It represents the common type of beet seed; when it is planted, several beets are likely to arise from the same point, and all but one of them will have to be pulled up by hand—a tedious and expensive operation. U. S. Department of Agriculture breeders therefore decided to make the sugar beet produce seeds with only one germ, such as is shown on the right, and their project has already reached such success that three-fourths of the seeds of their selected strain are now of this nature, whereas in ordinary beet strains not more than 5 per cent of the seeds are single-germ. (Fig. 7.)

approximately $3,000,000 annually for the entire beet acreage in the United States. Even if the multiple-seed balls are dropped in hills one seed ball in a hill, it is possible that in 99 per cent. of the hills there will be two or more plants in close proximity to each other. These plants, coming from the same seed ball, are necessarily so close together that they can not be reduced to one plant by any mechanical means that has yet been devised. Hence the only way to avoid this condition and to eliminate the expense and labor of thinning beets is to have all single-germ seeds.

BEGINNING OF THE WORK

The single-germ idea was suggested to Secretary Wilson in 1903 by Truman G. Palmer, Secretary of the Beet Sugar Manufacturers Association. Secretary Wilson approved the project and within twenty-four hours several hundred single-germ seeds had been selected, photographed and planted. Figure 7 shows a single-germ seed and a multiple-germ seed for comparison.

The first step in the solution of the problem was to grow roots from seed known to contain but a single germ. These seeds germinated freely and the plants grew vigorously, but since the beet does not usually produce seed the first year, it was necessary to store the roots and plant them out the second season for seed production. Hence the first crop of seed produced from single-germ seeds was in 1904. As was expected, there was a wide variation in the percentage of single-germ seeds on the various seed-producing plants in this experiment. In an effort to secure single-germ strains and to prevent crossing with plants of low potential with regard to singleness of germ, the most promising plants were covered with closely woven cloth bags. By promising plants is meant those that indicated by the number of single or isolated buds that the percentage of single germ seeds would be high. Further to insure the isolation of single flowers, all clusters of buds were carefully removed from some branches and the remaining buds were covered with paper bags, to prevent them from becoming pollinated with pollen from flower clusters. In many cases the pistils of the single flowers thus isolated were hand pollinated as soon as they were ready to receive the pollen. For this purpose pollen from flowers standing alone, that is, not in clusters, was used. Sometimes the pollen was taken from the plant bearing the flower to be pollinated, sometimes it was taken from other plants, thereby producing both close and cross fertilization. The work of hand pollinating was done under tents to guard further against unfavorable crossing.

Subsequent improvements have shown that in spite of all these precautions it was possible for unfavorable crosses to have been made by minute insects. However, our results indicate that we were in a measure successful in producing the pollination desired. Indeed, in our first generation of plants from seeds selected without any knowledge of their ancestry we found plants showing a single flower tendency and consequently a single-germ tendency to a marked degree. On the other hand, in some of the plants from single-germ seeds the flower clusters and consequent multiple seed ball tendency so predominated that the percentage of single-germ seeds was not appreciably greater than in plants grown from multiple-germ seeds. However, of the several hundred roots produced from single germ seeds over fifty produced upwards of 25 per cent. single-germ seeds.

RESULTS OF THE WORK

The fifty showing the highest number of single germs, as indicated in the bud stage, were selected, trimmed and isolated as thoroughly as possible in the manner indicated above. Having trimmed the best fifty plants, that is, removed all the flower clusters, leaving only the single flowers, it was obviously impossible for us to determine the percentage of single-germ seeds in this best fifty. The fifty-first plant selected was not trimmed and produced 25 per cent. single-germ seeds. The next best one had 21½ per cent., the next 21 per cent., and so on down to normal. A commercial beet seed field of 17 acres in the same locality was carefully searched and the plant having the highest number of single-germ seeds showed 4.77 per cent. by actual count, the average for the best ten in the commercial field being 2.7 per cent.

In the second generation the number of single germ seeds was upwards of 50 per cent. on the best plant and in the third generation it was about 75 per cent. Therefore, continuing along these lines, it is fair to assume that it is only a matter of time when a plant bearing only single-germ seeds will be produced.

To sum up the work, it is apparent that commercial beet plants normally produce a few single-germ seeds. Our problem was, by selection, to increase the proportion of single-germ seeds from less than 5% to 100. Our selected plants are now producing about 75% of single-germ seeds, and individual plants in a few cases show a somewhat higher percentage than this. The work and progress of single-germ beet seed

production is based upon the fact that certain beet plants possess the ability to so develop the seed stems that the buds and flowers are separated from each other in the process of growth. This tendency to separate the flowers and thereby to produce single-germ seeds seems to be transmissible from parent to offspring; whether or not this will become a fixed character time only can tell. The indications are that this character will become fixed and that a reasonable amount of care on the part of the beet seed growers will make the production of single-germ beet seed commercially practicable.

Success with Sugar Cane

Sugar cane breeding has been in process at the Louisiana Agricultural Experiment Station for nearly twenty years; the varieties D74 and D75, which make up about half the acreage of the State, were both put out by the station. Rice, cotton and tomatoes are also handled.

Sugar Cane Breeding

By selecting seedling sugar canes, the Porto Rico Agricultural Experiment Station has secured varieties that are notably more resistant to disease, give a larger tonnage and have a higher percentage of sucrose. Improvement of the pine-apple by seedlings is also under way. Those who have eaten the pine-apple will object that they know it has no seeds; but if cross pollinated, seeds are frequently developed. Conditions are the same with the banana, by the seeds of which, secured through crossing native varieties with fiber-producing species from the Philippines, the station is attempting to produce better races.

Controlled Cotton Breeding

Although a good deal of cotton breeding has been done in the United States, little of it has been so controlled as to afford reliable information about the manner of inheritance of characters of the cotton plant. The Mississippi Agricultural Experiment Station has taken up this study, using American Upland, Sea Island and Egyptian varieties in crosses, followed by isolation and self-fertilization. One of the interesting points involved is the extent to which Mendel's Law is obeyed in inter-specific as well as inter-varietal crosses, the claim being made by De Vries and others that where distinct species or genera are concerned, Mendelism rarely is demonstrable. The station also wants to produce cotton that, by ripening earlier, will avoid ravages of the boll weevil; this leads to a careful investigation of the numerous factors which combine to make the quality loosely termed "earliness," while the possible correlation between earliness and production of greater lengths of fiber is also being studied.

Would Utilize Bud Variation

The West Virginia Agricultural Experiment Station is endeavoring to take advantage of bud variation in sweet potatoes and strawberries, to improve the strains grown in that State.

OFFSPRING OF THE INSANE

Preliminary Report of Study of Ten Families Shows That Taint Ordinarily Does Not Manifest Itself in Filial Generation—Imperfection of Dominance Suggested by the Results.[1]

A. J. Rosanoff and Helen E. Martin
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Any study of the ancestors of the insane brings to light cases, not only of insanity, strictly so called, but also of various kinds and degrees of slighter neuropathic affection, some of which are not readily and sharply to be distinguished from the normal state. The material of such a study reveals, for the most part, not the manner and frequency with which insanity is transmitted from parent to offspring, but rather the frequency with which slightly neuropathic or even normal parents may, in some cases, beget insane offspring.

It may be that if satisfactory material could be made available for a study of a sufficiently large number of generations of ancestors the inheritance could in every instance be traced to cases of the same kind and gravity of neuropathic disorder as that which is taken as the starting point of the investigation and which all agree upon as being properly designated by the term insanity.

But the fact is that such material is not made available by even most thorough investigations and that the information secured concerning even the more immediate ancestors is apt to be indefinite and incomplete.

These considerations have led us to undertake the collection of material for a study of the offspring, in place of the ancestors, of the insane. The object of this report is to describe the plan of our study and some of the material that has been collected since its inauguration a little over a year ago.

The first feature of our plan is to select cases of patients who have offspring old enough to make possible a fairly definite judgment as to degree of intellectual development at its height and as to the presence or absence of notable nervous or mental anomalies.

No matter what theory of the mechanism of heredity may be preferred, it is now generally conceded that, in order to be complete, a consideration of the inheritance of any trait must take into account the facts presented by not one but both ancestral branches. In the present connection, it is hardly to be doubted that whether the offspring of an insane subject will or will not show evidences of neuropathic inheritance will depend not only upon the inheritable nature of the one parent's insanity but also on the nature of the mental inheritance from the other parent.

Accordingly, the second feature of our plan is to collect information concerning the consorts of the patients, the consort's parents and sibships, and other relatives if necessary or advisable.

The third feature of our plan is to make, as far as possible, direct observations of the offspring. The material is to consist not of ready judgments as to the normality or abnormality of subjects but of biographical facts and records of observation which might serve as basis for such judgments and which, if there be mental derangement, would make possible a comparison of its nature with that of the source of its inheritance.

The work is necessarily slow; the investigations of some families have been halted for one reason or another at

[1] Submitted to the annual meeting of the American Genetic Association, Berkeley, California, August 2-7, 1915.

various stages of their progress, and those of some others have had to be definitely abandoned.

Thus far we have completed the investigations, in accordance with the plan here outlined, of ten families, including a total of over 400 individuals.

The total number of direct offspring of the insane represented in this material is sixty-nine, and of these forty-one lived to an adult age. They are the offspring of five patients with dementia praecox, three patients with psychoses not definitely diagnosed but classified as allied to dementia praecox, one patient with paranoic condition, and one patient with epileptic dementia.

We hope, when our work is finished, to publish a full description of our material; for the present, we would submit the following general account of our findings:

In four out of the ten families that have been investigated all the offspring who survived to an adult age, sixteen in total number, were entirely normal so far as it was possible for us to judge. This part of our material, then, seems to support the view, already expressed in a previous study,[2] that the forms of insanity here dealt with behave in heredity as Mendelian recessives in respect of failing to appear in the first filial generation of hybrids.

In four other families some or all of the offspring showed slight or transient neuropathic symptoms interfering but little, if at all, with living at large and pursuit of ordinary occupations. This suggests, as a possible explanation, imperfection of dominance, for which some evidence in material of neuropathic inheritance has also been adduced[3]. The total number of offspring in these four families, which survived to an adult age, was seventeen; and of these eleven showed slight neuropathic symptoms, as mentioned above, the remaining six being entirely free from even such symptoms.

Of the offspring in the remaining two families, of whom nine survived to an adult age, two were insane and committed to institutions; one was insane a short time and committed suicide—the physician who was called in had suggested that she be sent to an institution; two showed slight neuropathic symptoms; and the remaining four seemed entirely normal.

The facts concerning the consorts of the patients and the consorts' parents, sibs, and other relatives, as we have them on record, contain much that would help to explain the contrasts presented by the fraternities of the ten families; we hope that some parts of the material may serve also as basis for the formulation of definitions of inheritable units in human mental constitution, for we do not believe that traits that can be tolerably well defined without reference to facts of their hereditary transmission are necessarily, or even probably, true biological entities.

[2] Rosanoff and Orr. *A Study of Heredity in Insanity in the Light of the Mendelian Theory.* Amer. Journ. of Ins., Vol. 68, Oct. 1911; also Bulletin No. 5, Eugenics Record Office, Cold Spring Harbor, N. Y.

[3] Rosanoff. *Dissimilar Heredity in Mental Disease.* Amer. Journal of Insanity, Vol. 70, July, 1913.

Bud Selection in Apples

At the Missouri Agricultural Experiment Station, bud selection is the subject of research in apples. Three crops have now been harvested from trees, part of which were grown from scions selected from high producing parents and part from parents of low producing habits. The difference in yield has not been large enough to be significant. "There was practically as much variation in yield of fruit and in size and color of fruit between trees from the same parent as there was between trees of different parentage."

APPLES OF THE CORDILLERAS

A Notable Case of Plant Migration—Fruit Now Grows Wild in Profusion—Introduced by Spaniards and Immediately Took Possession of the Country—Account of Early Explorer

Walter Fischer, *Washington, D. C.*

THERE are few of us to whom some one or all of the great movements or migrations among the myriads of our earth's inhabitants are not of more than passing interest, be they among plants or animals or among the races of man himself. In history the period of the great migrations is perhaps the most fascinating of all to the average reader. Census figures, showing the rapid growth and shifting of populations, aside from their special value and interest to the sociologist and business man, are of general interest to every one, as phenomena of nature. Hunters, stockmen and fishermen notice the movements and migrations of the flocks, herds and schools in which they are particularly interested, to say nothing of the appearance and disappearance of the flora and fauna upon which their charges and interests are dependent. The man who tills the soil, whatever his specialty may be, is undoubtedly most vitally affected by invasions and inroads of plants and animals, while for the nature student the opportunities for study and observation of such phenomena are extraordinarily rich.

The migrations of man lead all others in importance, not only on account of their magnitude in themselves but because, since his appearance in the field, practically all changes in the position and number of different species of plants and animals have been due directly or indirectly to his activities. Some of the changes going on in the fauna of a country are: the reduction, extermination and transfer of native species; the introduction of domestic animals and household pests; and the introduction and spread of insects and other forms of life that prey on animals and plants newly introduced or that chance to find unusual opportunities for development in a new environment. In the flora the changes that take place are similar: numerous species and individuals of cereals, vegetables, fruits and ornamental plants are introduced, to say nothing of the multitudinous plant pests, such as the weeds and fungous parasites which accompany them; while corresponding transformations take place in the native flora to make room for the new comers. Nature becomes cosmopolitan wherever man has left his footprint.

ADAPTATION TO NEW ENVIRONMENTS

The ready adaptation of certain species of plants and animals to their new environment, where they often thrive and multiply in a manner never dreamed of in their former home, is usually the object of no small wonderment. It is one of the most natural things in the world, however, and merely proves that the best conditions for their development are more or less duplicated throughout the world, often even more favorable in a new locality than in their old home, and that their distribution has been largely due to causes other than those that were responsible for their original evolution. In plant life we have been led to believe by our observations that herbaceous plants, and most commonly the annual weeds found near habitations or accompanying the sown crops, have been the most successful invaders and colonizers, and this on the whole is undoubtedly true. These very weeds, however, in most cases and in a certain sense, are domesticated plants largely dependent upon artificial surroundings to which, like the more useful plants, they have

WILD ARGENTINE APPLE TREE

In some parts of Argentina and Chile, the apple has found particularly congenial surroundings, and appears to have escaped from cultivation within a few years after the Spaniards introduced it. With incredible rapidity it established itself through the river valleys, and now gives every appearance of being absolutely at home. Photograph in the valley of the Alumine River, Territory of Neuquen, Argentine Republic. (Fig. 8.)

conformed themselves and in which, in spite of our efforts at extermination, they find the most favorable conditions for growth. Shrubs and trees, although just as successfully transferred to new countries by the help of man, more rarely are invaders of their own accord or become aggressive in their new surroundings. By their very nature and size, there is little chance for them to escape destruction under the artificial conditions where herbaceous plants flourish, and, as in the case of those herbaceous plants which have actually been able to escape and compete successfully with the indigenous species in their own habitat, those that survive are few in number and exceptional. It is of such an exceptional case that this article treats.

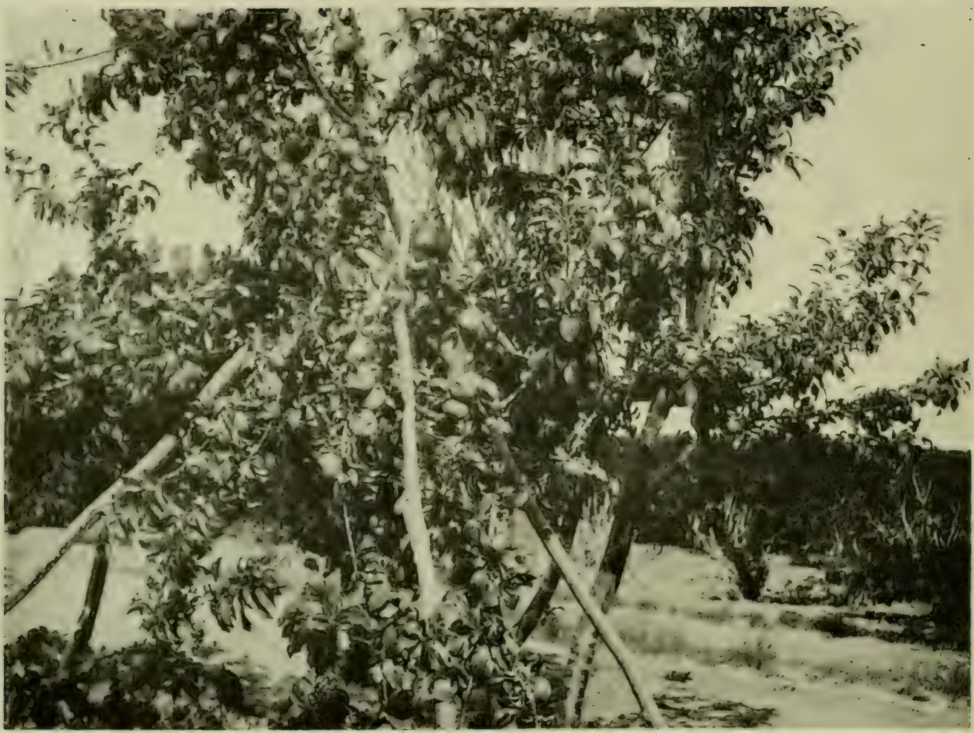
The apple is, generally speaking, the best known and most widely planted of all trees. The first and most natural inference, at least as far as it relates to any of the newly discovered continents, is that it was introduced from elsewhere, and that inference is correct. Its exact place of origin is obscure but that it came from the old world is certified by historical records of its use and cultivation in very ancient times and more especially by the charred remains of apples that have been found in the Swiss lake dwellings, which flourished probably 2000-4000 B. C. It is now grown in all countries of the temperate zone where it usually escapes from cultivation to a limited extent. It furnishes a good example of what was said above about plants or animals often doing better in a new locality than in

their original home. It is generally recognized, for instance, that, under cultivation at least, it has found more favorable conditions for its development in North America than in Europe or Asia from whence it originally came, although it has never escaped to a large extent nor gone far from the orchard or fence corner. De Candolle speaks of the apple as "appearing most indigenous" in the region between Trebizond and Ghilan in Persia. It is doubtful, however, whether it appears more indigenous there than it does in the southern Cordilleras of Chile and Argentina. In this case the question as to whether it is indigenous or not could hardly arise, and its presence there constitutes one of the most remarkable phenomena in the great movements of plants on this earth.

THE CORDILLERAN APPLE COUNTRY

Roughly speaking, the wild apple country of Chile and Argentina is cut in half by the 40th degree of latitude south, having a total extension of about 200 miles north and south and lying on both sides of the continental divide. In Chile it extends to the Pacific coast and in Argentina to the eastern limit of tree growth. The Argentine side without doubt, on account of the more definite landmarks in the history of its settlement, offers the more interesting and profitable field for study. The heart of this apple country, a region of many mountain lakes, snow-capped peaks, small rivers and valleys, vying in scenic beauty with the Alps and the Yosemite, lies just north of the beautiful lake Nahuel Huapi, between the river Limay and the divide, and drained for the most part by the Colloncura, a branch of the Limay, and its extension the Alumine. The general level above the sea of the valleys is about 3,000 feet; there are no extremes of temperature, the minimum, so far observed, being 7° F. The region lies within the sphere of the western trade winds of the southern hemisphere which bathe the Chilean slopes of the Andes in the same latitude with from 100 to 120 inches of rain annually, but which lose their moisture on contact with the cold Andean peaks and sweep down on the eastern side with great velocity and drying powers. One small district still has, however, the greatest rainfall of any in the Argentine Republic, something like 75 inches at San Martin de los Andes not so very far from the Chilean boundry; but it varies greatly, amounting to only 32 inches at Junin de los Andes, for instance, not more than 20 miles distant, and decreasing to about 15 inches at the beginning of the Patagonian tablelands in the interior. About three-fourths of this precipitation occurs during the winter months, making the seasons similar to those of the Pacific Coast and the Mediterranean. The indigenous vegetation varies with the rainfall and according to the amount of protection found against the cold drying winds from dense rain forests, similar to those of Washington and Vancouver, with almost impenetrable undergrowth, and more open coniferous forests of Araucaria, to mountain meadows and dry grass-lands bordered and broken by forests or clumps of trees and shrubs. In the moister regions, strawberries, currants and potatoes are native, while white and red clover, timothy and other grasses have escaped from cultivation. The region is quite thickly dotted with ranches and settlements at the present time, although not yet accessible by railroad.

The apple is especially abundant in the valleys of the Alumine and its continuation the Colloncura, their numerous tributaries and the lakes which drain into them. It is found along the borders of forests, streams and lakes and reaches its greatest development in the regions of moderate rainfall, where it is found singly or in groups wherever there is some protection from the cold dry winds, in sheltered valleys and ravines, and especially near streams and springs where the roots can find water. It is *Pyrus malus* L., the apple that is planted throughout the world; all plants are seedlings, of course, and the fruit, as might be expected, is of all sizes, forms, shades, flavors and degrees of sweetness and acidity. Where the trees are much exposed they seldom bear on account of the hard winds prevalent at blossoming time. But on



GROWING UNDER CULTIVATION

A wild apple of the Cordilleras, domesticated in the Rio Negro valley. When given some care, these trees bear large crops of fruit, and although the quality is very diverse, as is usual with seedlings, much of it is good. (Fig. 9.)

many branches the apples are gathered to the extent of hundreds of bushels and usually made into cider, or they are eaten by the numerous herds of cattle that range the mountains. The woolly aphis has commenced its depredations among the trees and is fast penetrating to the most remote.

HISTORICAL RECORDS

The generally accepted explanation of the apple in this region is that it was introduced by the early Jesuit missionaries. The oldest record found is that in the diary of D. Basilio Villarino, pilot of the royal armada, who had been ordered to lead an expedition up the Rio Negro from the sea for the purpose of reaching Valdivia on the Pacific coast by an overland route. His voyage lasted 8 months, from the twenty-eighth day of September 1782 to the twenty-fifth day of May, 1783, only three weeks of which were needed for the return. Hardly a month out, October 26, and not yet far from the Atlantic coast, he speaks of the *Tierra de las Manzanas* (apple land), about which he had heard through the Indians that were accustomed to descend to the Pampas in search of cattle and horses. By January 23 he had reached the juncture of the rivers Neuquen and Limay, and ascending the latter, about three weeks later, his advance party brought in branches from apple trees found on the banks of a small stream flowing into the Limay from the west. Unfortunately, for the purpose of his expedition, Villarino did not continue to follow the Limay to its source, but went up the Colloncura which was more easy of navigation; he then probably proceeded up the Chimehuin, a river flowing into the Colloncura from the west just a little north of the 40th parallel, to the neighborhood of lake Huechulaufquen. Almost daily,

while navigating up these two rivers, his scouting parties brought in apples that they had got by barter from the Indians. He mentions apples weighing as high as 17 ounces and remarks about what good apple gatherers the Indians were as they never left "even one" on the trees found by his men. The Indians made *chicha* from them, evidently a kind of cider, and *orejones*, dried apples. The following is a literal translation of the entry in Villarino's diary for the twenty-ninth of April, 1783, probably written not very far from the present town of Junin de los Andes:

"It dawned cloudy, with the wind W. strong and very cold. At 8 it commenced to clear, and I set out to observe the latitude of the mouth of the River Huechum-Huechuen; I returned at 4 in the afternoon. Today the *Chinas* (Indian women) led in fifty to sixty packs with apples. They set out at 8 o'clock and returned at 2 in the afternoon; others who set out yesterday noon, returned today at 4 o'clock in the afternoon, and these say they went to Huechum-Huechuen, because the apples from there are much better than those from other parts. I could very easily and at small cost have loaded the shallops with this fruit, but the apples came all bruised and battered, not only because they pick them up from the ground when they are already bruised from the fall, but because of striking and rubbing against one another in the packs, through the motion and trotting of the horses, so that few sound ones remain that can be saved. I put on board more than 8,000 and inspecting them this afternoon found them nearly all rotted: so that I think I shall inspect them tomorrow, and of the pieces which I find sound make *orejones*. Many are the varieties of the apples on hand, and in flavor the apples of Galicia, my native land, surely do not excel them. This evening they brought me twelve pippins, which they were able to select from the less bruised; it is surely a pleasure to look at them, and apples of this kind are called *repiñaldos reales* in my country. In none of all the places ever traversed by me, were there such good apples and such a variety and abundance as here. . . ."

On the following fourth of May, discouraged by sickness among his men, by the hostility of the Indians to his plans and by the approaching snows of the season, Villarino started out on his return voyage.

And now as to the date of the first possible introduction of the apple into the region east of the Andes, from which its rapid and remarkable spread might be traced. The Spaniards first attempted to conquer and settle southern Chile between the years 1541 and 1551, those being the dates of the founding of Santiago and Valdivia on about the 33d and 40th parallels of latitude respectively. In 1553 Francisco de Villagran, a captain of Valdivia, crossed the Andes in 39° latitude as far as a large river (perhaps the Alumine) and in the same year most of the settlements in Chile were destroyed by the Araucanians, followed by nearly 100 years of almost incessant warfare until the peace of Quillen in 1640 (which was soon followed by other wars, however), allowed the Indians undisputed sway over all the territory south of the Bio Bio, or 37° and 38° latitude. The first settlement east of the Andes was that of the Jesuit mission founded by Nicolas Mascardi in latitude 41 on the shores of lake Nahuel Huapi in 1670, but destroyed in 1717. Unsuccessful attempts at its restoration were made in 1764 and, outside of a few other unimportant expeditions which could have left no impression upon the region, and the notable expedition of Villarino in 1783, the country was left undisturbed by white men until settled during the latter half of the nineteenth century by the gradual infiltration of settlers from Chile and still later from Argentina.

Taking into account the unsettled conditions on the Chilean side of the southern Andes or Cordilleras and that the eastern side had hardly been touched by white men, and above all that the influence of the Jesuits was never great among the Araucanians and Transandine tribes, the wide distribution of the apple in a region so remote at such an early date as 1783, is truly remarkable. It proves that it spread very rapidly either from the solitary mission post on Nahuel Huapi or through the passes in the Andes from Chile, or both, by natural means such as animals or semi-savage Indians and water currents, and that it found exceptionally congenial conditions for its development. A closer study and comparison of this region with some of those parts of the old world where the apple appears indigenous might throw additional light on its origin.

FROG'S HAIR

African Batrachian Possesses Hair-like Appendages Whose Origin Is Shrouded in Mystery—Probably Secondary Sexual Character

"FROG'S HAIR" has long been an ingredient of popular metaphor, and considered as mythical as the equally famous "hen's teeth." When, therefore, G. A. Boulenger described in 1900 two frogs from the German Congo which had a partial covering of what looked very much like hair, his description did not fail to awaken a deal of interest, among those who came across it.

Were the mammals to lose one of their distinguishing characteristics, through its extension to the frogs? Boulenger admitted that he did not know much about it, but said that these "villose dermal papillae" were not a nuptial attribute of the males, but were rather more strongly developed in the female than the male. He suspected them of being a seasonal appendage.

In 1902 he published another short paper on the subject describing seven more specimens of the same species (*Astylosternus robustus* Blgr.). In this case the females showed no trace of the appendages, while in the two males they were fully developed. The specimens were evidently obtained during the breeding season.

Meantime Dr. H. Gadow had made a microscopical examination of the hair-like structures, and reported that he was unable to find any nerves in them, although he made out some insignificant blood vessels and lymph spaces. He concluded that these appendages could not be considered a sensory apparatus, and agreed with Boulenger that their function was a mystery.

There the case remained until Willy Kükenthal, working in the Museum of Comparative Zoology at Harvard College, reviewed it[1] by the study of eleven specimens from Kribe, Kamerun. He established that the hair-like appendages were present only in the males, and altogether wanting in the females. This confirms Boulenger's second report; evidently his first one was an error.

It was further found "that these appendages do not attain the same degree of development in all male individuals, and that even in full grown males there are very conspicuous differences in this regard."

He believes, although data are few, that the hair-like covering is most highly developed during the breeding season, and that it is to be considered a secondary sexual characteristic.

"The fact that a younger (smaller) male, contained in the same jar with the two adult males possessing fully developed appendages—and therefore apparently captured at the same time with these—showed this hairy coat in its beginnings, points to the conclusion that the appendages are fully developed only on adult animals and probably, as I have already suggested, at the time of mating.

"Now arises the question, from what do these organs originate? The reply requires a careful investigation of the female. It is quite surprising, that none of the former investigators has observed the fact, that the females have, on exactly the same parts of the body that on the males bear these appendages, small but quite distinct tubercles, which have the same diameter as the bases of the appendages in the males. Their distribution over exactly the same areas of the surface shows clearly that they are homologous with the appendages of the male.

"Moreover, if we carefully study the surface of the skin, we find that both males and females show similar tubercles scattered over the whole back, and that they are more closely crowded in the region of the angle of the jaws. In some areas of the surface of the males

[1] Bull. Mus. Comp. Zool. at Harvard College, Vol. LIII, No. 9, pp. 371-376, 2 figs., 5 plates.

A "HAIRY" FROG FROM THE GERMAN CONGO

Owing to the extraordinary development of tubercles on the skin, this species seems to have hair. The hair-like appendages appear to be a peculiarity of the males only, and to be most highly developed among adults, and at the breeding season. They apparently serve as sensory organs, and are to be considered a secondary sexual characteristic, but their exact purpose is a matter on which one can hardly even guess with profit. From Kükenthal. (Fig. 10.)

we may even observe the transition of these tubercles into villose appendages. From these comparisons we must therefore draw the conclusion that these appendages have arisen from tubercles of the skin, such as we find scattered over the skin of this species in other regions of the body and such as are recorded from other Ranidae.

"These hair-like appendages are therefore to be considered as highly developed tubercles of the skin."

Mr. Kükenthal then had recourse to the microscope, and arrived at quite different conclusions from those of Herr Gadow. In particular, he found that the organs contain both nerves and nerve-terminations, "and that therefore they do serve as sensory organs."

As to the exact function of these peculiar appendages, one can only guess. Evolutionists will certainly hope for observations on living specimens, in order that some light may be thrown on the cause which called forth this hair-like covering, so different from anything found on other frogs.

NEW PUBLICATIONS

Report of the Commission to investigate the extent of feeblemindedness, epilepsy and insanity and other conditions of mental defectiveness in Michigan. Lansing, Mich., Wynkoop, Hallenbeck Crawford Co., State Printers, 1915.

In 1913 the Michigan Legislature appointed a commission to make a survey of the State and report on the amount of mental defect in the population. The 175 page report of this commission makes a startling document, although it is not to be supposed that conditions are worse in Michigan than in most other states of the Union. It is found that there are 7,703 insane in institutions, of whom probably two-thirds owe their insanity to heredity, and that the various county infirmaries and reform schools are crowded with people, many of whom are feebleminded. Many of these are set at liberty each year, to reproduce their kind, and many insane persons are similarly uncontrolled. The State laws prohibiting marriage to these classes are not enforced, and the Michigan sterilization law is practically a dead letter. A general reorganization of the method of caring for defectives in the State is necessary; but as the commission points out, the first, cheapest and most effective thing to do is to segregate at least the female defectives for life.

Insane and Feebleminded in Institutions in 1910. Department of Commerce, Bureau of the Census. Washington, D. C., Government Printing Office, 1914.

Statistics in regard to the insane and feebleminded in the United States in 1910 have been published by the Bureau of the Census, with an analysis by Joseph A. Hill. It is reported that the number of insane in institutions was 248,560, an increase of 25.1% over the figures for 1904, while the general population of the United States increased only 12% in that time. This indicates, in part, that more insane are being segregated, rather than that insanity is increasing so rapidly. A summary of laws relative to the care of the insane is presented. The number of feebleminded in institutions was 33,969, but there is reason to believe that the number in the United States is well above 200,000,—effective institutional segregation of the insane has gone far ahead of similar segregation for the feebleminded. Even of the small number of feebleminded who are in institutions, 40% are in almshouses.

A WORKING MODEL OF MENDELISM

W. Burns

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ONE of the first things told to a student of Mendelian inheritance is that the distribution of characters is according to the law of chance: but to those who have not learned to think mathematically, chance in the abstract means little. I have, therefore, used the following method for the last five years to demonstrate the 3:1 ratio in the simplest case of Mendelian inheritance, and the way in which it is controlled by chance.

Take two packs of playing cards without jokers, each containing the usual fifty-two cards only. Put the red cards (hearts and diamonds) from both packs into one heap, and the black cards (spades and clubs) into another heap. These two heaps are now looked on as masses of male and female gametes, or germ-cells, of two plants (the supposition would hold equally for animals), one having a red character, and the other a black character.

If these two hypothetical plants are crossed, we have a black gamete uniting with a red gamete to make the zygote or fertilized egg-cell from which the new individual develops. To represent the cross, we take a card at random from each heap, as represented in Fig. 11.

Fig. 11

As red and black cannot be well distinguished in a photograph, I have represented the red cards by black with white bars. These cards represent the parental generation.

Black is dominant in this cross; the hybrid produced from such a union therefore shows only the dominant character (black), the red being hidden behind it—recessive, to use the technical term. This is shown in Fig. 12; the red

Fig. 12

has been allowed to stick up, in order that its existence may be seen. In the actual plant, the individual will show only the black, the red being wholly latent. This generation is designated as the first filial or F_1 generation.

We now assume that this hybrid plant of ours, showing the black dominant character, but still carrying the red as recessive, is self-fertilized. To illustrate the process of self-fertilization, make up both packs properly again, and shuffle each very thoroughly. Each pack will then consist of twenty-six red and twenty-six black cards, mixed

up anyhow. The right-hand pack represents the female gametes, and the left-hand pack the male gametes.

Now take up one card from the top of each pack, as shown in Fig. 13.

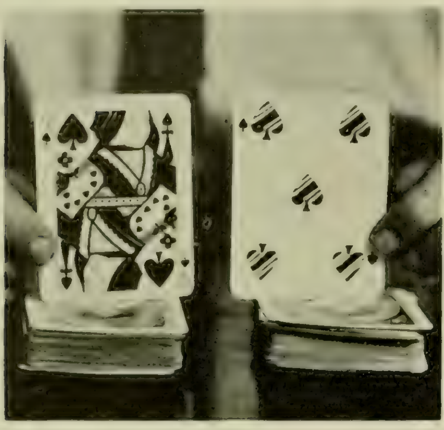


Fig. 13

There are four possible pairs which you can pick up in this way: Red Black, Red Red, Black Red and Black Black. Make four columns on the blackboard or a sheet of paper, with these headings, and put down a unit for every combination as it is taken up from the packs. If the cards have been thoroughly shuffled there will be thirteen units under each heading. If the cards have not been thoroughly shuffled, there may be a deviation: instead of 13, 13, 13, 13, we may get 12, 14, 14, 12, or something similar. If this occurs, shuffle the same packs and try again. I have always found that the ratio comes out correctly the second time.

Taking up the analogy again, we have the combination Black Black representing the pure dominants. Their germ-plasm has thrown out the red altogether and contains nothing but black; as long as they are self-fertilized, they will breed pure black generation after generation.

The next two combinations are Black Red and Red Black; but as black is dominant, it is evident that these will look and behave just alike, the black in each case concealing the red, which remains recessive or latent. These combinations are known to the Mendelist as heterozygotes, or impure dominants, while the pure black or pure red is called a homozygote.

Finally, the combination Red Red represents the pure (or "extracted," as it is often called) recessive. This line of germ-plasm has gotten rid of all the black, and will breed pure red indefinitely, provided it be self-fertilized and no new dominant introduced.

As to the heterozygotes, the Black Red and Red Black combination, it will be evident to the reader, if he thinks back over the whole process, that when they are *again* self-fertilized, they will again split up into the simple Mendelian proportion of three dominants (two of which are impure) to one recessive. And so the process goes on, generation after generation, where a single pair of contrasted characters (called "allelomorphs") is concerned, each generation seeing a segregation of the characters according to the law of chance, just as if the characters were shuffled about by Nature as we shuffle the cards; and each generation seeing a repetition of the famous 3:1 ratio.

Improving Native Grapes

Like several other southern States, Georgia is endeavoring to exploit the hardy native grape (*Vitis rotundifolia*), either through selection or hybridization. So far the work accomplished at the State Experiment Station has been preliminary, and devoted to a study of the behavior of the white scuppernong variety under carefully controlled conditions, so that its characters could be determined. The pecan, which has attained considerable importance in the South during recent years, is also under investigation, to determine why a number of trees are self-sterile, and what advantage lies in keeping such trees in an orchard.

EXTRA-FLORAL NECTARIES

OF THE many adaptations of flowers to secure that cross-pollination which ordinarily seems to be so advantageous to them, none is of more obvious use than the nectary. If it is desirable for the flower to attract insect visitors, surely nothing could be more attractive than a reservoir or fountain of nectar, from which they can drink.

Early botanists indeed were considerably puzzled by the case. Patrick Blair guessed that the honey absorbed the pollen and thus fertilized the ovary; Pontedera thought it kept the ovary in a moist condition: Linnaeus "gave it up;" "Krünitz thought he observed that in meadows much frequented by bees the plants were more healthy, but the inference he drew was, that the honey, unless removed, was very injurious, and that the bees were of use in carrying it off."

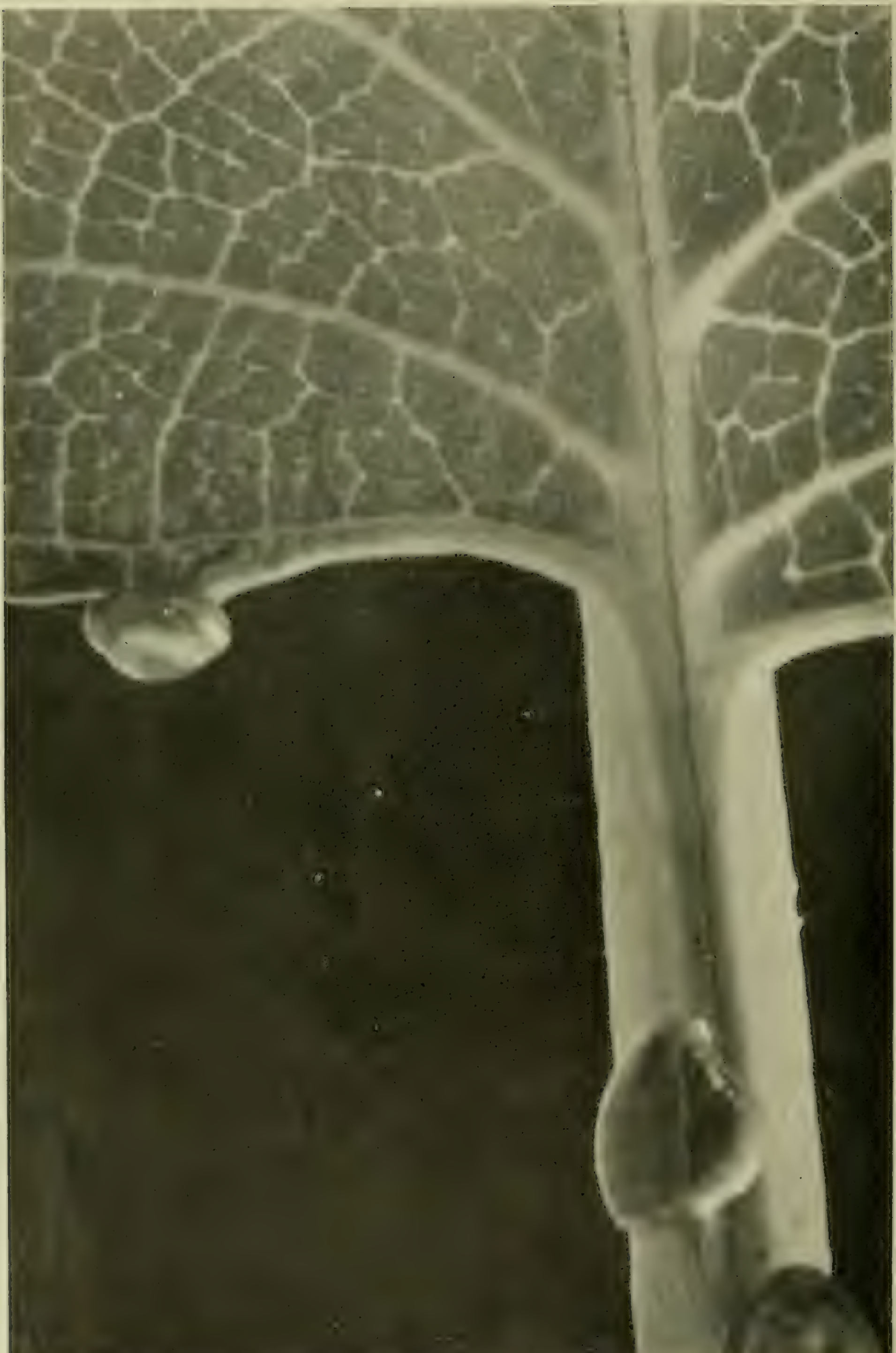
But since the cross-pollination of plants, and the part that insects play in it, have been understood, there has been little doubt as to the utility of nectaries in most flowers.

When, however, we come to nectaries outside the flowers, such as not a few plants possess, we are obliged to pause for consideration. Such nectaries can be seen to good advantage on the leaf-stem of any cherry, on the passion flowers (for example, the "may-pop," *Passiflora incarnata*, of the United States), on the cowpea and various other legumes, on the castor bean (*Ricinus communis*), and on many other less common plants. The accompanying photographs show the extra-floral nectaries at the base of cherry leaves, where there are usually two, and sometimes half a dozen, which may be not only on the petiole, but on the margin of the leaf itself.

The early Darwinian school of naturalists, who felt it necessary to find a purpose for the existence of *every* feature of an organism, in order to account for its development through natural selection, spent a good deal of ingenuity on the extra-floral nectary. In the numerous cases where this gland is on the flower-stem or close to the flower, it was suggested that its purpose was to act as a sort of "blind" for ants, which might otherwise enter the flower itself, in their search for honey, and thus self-pollinate it. If they found a nectary at the base of the flower, it was argued that the ants would satisfy their needs from it, and depart without upsetting the flower's plans for cross-pollination.

The idea that extra-floral nectaries were a special appeal to ants was developed most fully by Belt and Delpino, the former of whom about forty years ago published his description of the remarkable bull-horn acacias of Central America, in the huge spines of which colonies of ants make their homes, feeding on syrup from extra-floral nectaries, and paying for their entertainment by protecting the tree from all other living things. Describing these acacias, W. E. Safford writes: "The bi-pinnate leaves have nectar glands on the rachis and petiole, as in many other acacias and they are still further provided with peculiar processes on the tips of the leaflets, minute, wax-like bodies rich in oil and protoplasm, which Thomas Belt in his *Naturalist in Nicaragua* (1874) discovered to be used as food by the ants inhabiting the spines, and which in his honor were named Beltian bodies." F. Delpino, in a classical work on the subject (*Funzione mirmecofile nel regno vegetale*, 1886-9) brought together many other illustrations of these supposedly protective nectaries outside the flower proper, enumerating their occurrence in 3,030 species of 292 genera, of which 563 are in America. The greatest number is in the pea family (Leguminosae), closely followed by the Euphorbiaceae or spurge family.

Microscopical examination of these nectaries at various stages shows that their development takes quite different courses in different species. There



NECTARIES ON A CHERRY LEAF

Photograph showing, greatly enlarged, a portion of the flower edge and petiole or leaf-stem of a Japanese flowering cherry leaf. Projecting from the lower edge of the leaf, looking like a small acorn, is an extra-floral nectary. The acorn cup is the nectary and what looks like the acorn is a drop of nectar which has exuded and has not yet been lapped up by ome hungry ant. Down on the leaf-stem are two more large nectaries. (Fig. 14.)

A CLUSTER OF EXTRA FLORAL NECTARIES

Nectar is ordinarily thought of as a product of flowers, but some plants also excrete it from leaves and stems. This photograph of a cherry leaf-stem gives a vivid idea of the profusion with which nectar-glands are sometimes formed outside the flower. Three large extra-floral nectaries can be seen on the stem, while the margin of the leaf bears half a dozen more, most of them not functional. When they are functional they are visited by ants and various other insects, but their presence seems to be of no particular advantage to the tree. Highly magnified. (Fig. 15.)

seems to be no single underlying principle governing their appearance. Their secretions also vary widely, although in general they give off merely a kind of sugar-water, containing varying proportions of dextrose, levulose and sucrose.

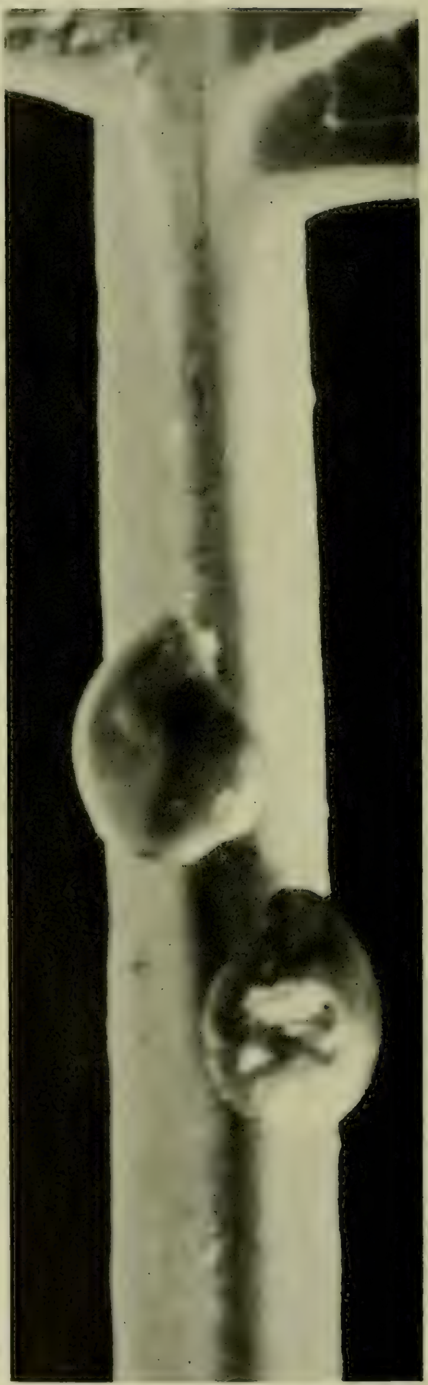
When, only a few years ago, naturalists generally began to realize that there might conceivably be parts of an organism which had no particular use, and that the appearance of such parts could be perfectly explained in various ways, without resorting to the principle of natural selection, and that their useless existence, further, would not cause the whole structure of organic evolution to totter on its foundation, the extra-floral nectaries began to be examined in a more critical way.

Numerous plants with extra-floral nectaries have been deprived of these organs, but it has been found that they produce the normal amount of seed just the same, and that none of their activities appears to be altered.

Further, it has appeared that plants which attract ants by extra-floral nectaries sometimes have their flowers more robbed by ants, than would probably be the case if they lacked extra-floral nectaries. The idea that the presence of such nectaries is a "sop" to divert the attention of ants from the greater treasures in the flowers, therefore, appears to have little basis in fact, as far as observation goes.

Again, in some of the broad beans (Vicia), it has been found that bees visit the extra-floral nectaries, in preference to those in the flower. In such cases, the flower may fail altogether to be cross-pollinated; evidently, then, the presence of extra-floral nectaries is in these cases a distinct disadvantage rather than an advantage to the plant.

Finally, the theory that nectaries outside the flower are intended to protect those inside the flower from unwelcome visitors, would seem to demand that the two sets of nectaries be functioning at the same time. But in point of fact, it has been observed that there is rarely exact correspondence in time, and that in some cases the chief secretion of extra-floral nectar occurs before, in others after, the period when



NECTARIES ON LEAF STEM

Photo-micrograph of cherry petiole, showing two typical extra-floral nectaries. (Fig. 16.)

the flower is open and seeking visits from its limited list of select visitors, for cross-pollination.

But the fact that extra-floral nectaries occur also on some ferns, *which have no flowers*, indicates most forcibly that the function of these structures is not necessarily to take part in the plant's schemes for avoiding self-fertilization.

If one must form a general theory covering all cases, it would seem that the most plausible in regard to the extra-floral nectaries is that they have no rôle of real importance. This idea would have shocked most of the early Darwinians, who would have felt it impossible to account for the origin of the structures, unless through their value to the plant in securing its survival. But most naturalists now agree that there are many structures in every plant and animal which have no conceivable function of real importance, and which can hardly have arisen and been maintained because of their survival-value. As to how such things originated, we are obliged sometimes to admit that "they just happen;" that there seems to be no particular reason. Once there, they remain; for, if they are of no particular advantage, neither are they of any particular disadvantage.

It is admittedly dangerous for Man to assume that he can understand all the ways of Nature and decide by his own standards whether or not a certain structure is of value to a plant. But so far as our observation can guide us, it appears that in many cases, at least, extra-floral nectaries must be looked on as little better than accidents in the development of the plant; they may, of course, have been more useful at some earlier stage in the plant's evolutionary history, but at present we can hardly avoid the conclusion in many cases that they have no vital function and that the plant would probably get along just as well without them.

Inheritance in Flowers

Two lines of experiment of strictly genetic interest have been undertake by the Pennsylvania Agricultural Experiment Station—namely, a study of the inheritance of flower form and color in *Phlox drummondi*, and a similar study in *Mirabilis jalapa*, the Four O'clock. Both these flowers are among the stock in trade of genetists; the latter is particularly rich in surprises. Correns, for instance, crossing a white with a cream-color, got eleven kinds of red, white, yellow and striped offspring among the grandchildren. In the cross of white and red Four O'clock occurs one of the classic examples of blended inheritance, the color of the hybrid generation being pink, while in most plants the color of one parent dominates in the hybrid generation to such an extent that it completely masks the other. The station is also attempting, in tobacco, to find why hybrids are sterile, particularly in cases where germination is low and where seedlings fail to mature.

Genetics in New Jersey

The New Jersey Agricultural Experiment Station, one of the pioneers in plant breeding, has the following projects under way: Inheritance of size and form in tomatoes; inheritance of pungency and of morphological characters in peppers; inheritance in crosses of popcorn with flint, dent and flour varieties, and in hybrid beans and egg plants, the object of the last project being to produce a true spineless commercial kind. A hybrid okra has been developed that may be of value as an ornament. Wide crosses are being made with the Prairie-berry (*Solanum nigrum ?*). An interesting experiment under way is to test the correlation between variability and vigor in a population; while the inheritance of prolificness is being tested in beans, tomatoes, peppers and soy beans, one of the objects being to find out the value of barren plants in any population.

GENEALOGY AND EUGENICS

Study of Human Lineage Can Be Greatly Increased in Value if Illuminated by Genetics—Methods To Be Followed—Results To Be Expected.[1]

THE EDITOR

SCIENTIFIC plant breeders today have learned that their success often depends on the care with which they study the genealogy of their plants.

Live-stock breeders admit that their profession is on a sure scientific basis only to the extent that the genealogy of the animals used is known.

Human genealogy is one of the oldest manifestations of man's intellectual activity, but until recently it has been subservient to sentimental purposes, or pursued from historical or legal motives. Biology has had no place in it.

Genealogy, however, has not altogether escaped the re-examination which all sciences received after the Darwinian movement revolutionized modern thought. Numerous ways have been pointed out in which the science—for genealogy is certainly a science—could be brought into line with the new way of looking at Man and his world. The field of genealogy has already been invaded at many points by biologists, seeking the furtherance of their own aims.

I propose to discuss briefly the relations between the conventional genealogy and the modern application of biological principles to everyday life which, as it is here viewed, may be broadly described by the name Eugenics, "good breeding." It may be that genealogy could become an even more valuable branch of human knowledge than it now is, if it were more closely aligned with biology. In order to throw light on this possibility, we must inquire:

(1) What is genealogy?

(2) What does it now attempt to do?

(3) What faults appear, from the eugenist's standpoint, to exist in its present methods?

(4) What additions should be made to its present methods?

(5) What can be expected of it, after it is revised in accordance with the ideas of the eugenist?

The answer to the first question, "What is genealogy?" need not detain me long, for you are already more familiar with it than I am. Genealogy may be envisaged from several points. It serves history. It has a legal function, which is probably of more consequence abroad than in America. It has social significance, in bolstering family pride and creating a feeling of family solidarity—this is perhaps its chief office in the United States. It has, or can have, biological significance, and this in two ways: either in relation to the pure science or the applied science. In connection with pure science, its function is to furnish us means for getting a knowledge of the laws of heredity. In application, its function is to furnish a knowledge of the inherited characters of any given individual, in order to make it possible for the individual to find his place in the world and, in particular, to marry wisely. It is obvious that the use of genealogy in the applied science of eugenics is dependent on the preceding use of it in the pure branch of the science; for marriage matings which take account of heredity can not be made unless the laws of heredity have previously been discovered.

The historical, social, legal and other aspects of genealogy do not concern the present paper. I shall discuss only

[1] Address before the International Congress of Genealogy, San Francisco, Calif., July 26-31, 1915.

the biological aspect: first, because I am incompetent to discuss the others; and secondly, because I hold that the biological conception has by far the greatest true value, accepting the criterion of value as that which furthers the progressive evolution of the race. By this criterion, I believe the historical, legal and social aspects of genealogy are of secondary importance; the greatest worth it can possibly have is in coöperation with biology. This definition may appear to be a begging of the question of my whole paper; I shall attempt to justify it farther on.

(2) Genealogy now too often professes to be an end in itself. It can, of course, be looked upon as an end in itself, but I believe that it will be recognized as a science of much greater value to the world if it is admitted to be not an end but a means to a far greater end that it alone can supply.

It has, indeed, been contended, even by such an authority as Ottokar Lorenz, who is often considered the father of modern scientific genealogy, that a knowledge of his own ancestry will tell each individual exactly what he himself is. This, as I understand it, is the basis of Lorenz' valuation of genealogy. It is a step in the right direction: but

(3) The present methods of genealogy are inadequate to support such a claim. Its methods are still based on the historical, legal and social functions, and it has not yet begun, save in a few instances, to realize its almost incomparable opportunity for the betterment of mankind. Let me indicate just a few of the faults of method in genealogy, which the eugenist most deplores:

(a) The information which is of most value is exactly that which genealogy ordinarily does not furnish. Dates of birth, death and marriage of an ancestor are of interest, but rarely of real biological value. The facts about that ancestor which vitally concern his living descendant are the facts of his character, physical and mental; and these facts are given in very few genealogies.

(b) Genealogies are commonly too incomplete to be of real value. Sometimes they deal only with the direct male line of ascent—what animal breeders call the tail-male. In this case, it is not too much to say that they are nearly devoid of genuine value. Fortunately, American genealogies do not often go to this extreme, but it is not uncommon for them to deal only with the direct ancestors of the individual, omitting all brothers and sisters of those ancestors. Although this simplifies the work of the genealogist immensely, it deprives it of value to a corresponding degree.

(c) As the purpose of genealogy in this country has been largely social, it is to be feared that in too many cases discreditable data have been tacitly omitted from the records. The anti-social individual, the feebleminded, the insane, the alcoholic, the "generally no-count," has been glossed over. Such a lack of candor is not in accord with the scientific spirit, and makes one uncertain, in the use of genealogies, to what extent he is really getting all the facts. There are few families of any size which have not one such member or more, not many generations removed. To attempt to conceal the fact is an action of doubtful ethical propriety; but from the eugenist's point of view, at any rate, it is a falsification of records that must be regarded with great disapproval.

(d) Even if the information it furnishes were more complete, human genealogy would not justify the claims sometimes made for it as a science, because, to use a biological phrase, "the matings are not controlled." We see the results of a certain experiment, but we can not interpret them unless we know what the results would have been, had the precedent conditions been varied in this way or in that way. We can make these controlled experiments in our plant and animal breeding; we have been making them by the thousand, by the hundred thousand, for many years. We cannot make them in human society. Of course, we don't want to; but the point on which I wish to insist is that the biological meaning of human history, the real import of genealogy, cannot be known unless it is interpreted in the light of modern plant and animal breeding. It is absolutely

necessary that genealogy go into partnership with genetics, the general science of heredity: that it do not consider itself cheapened by an alliance with the plant and animal breeders. If a spirit of false pride lead it to hold aloof from these experiments, it will make slow progress. The interpretation of genealogy in the light of modern research in heredity through the experimental breeding of plants and animals is full of hope; without such light, it will be discouragingly slow work.

Genealogists are usually proud of their pedigrees; they usually have a right to be. But I beg of you, do not let your pride lead you to scorn the pedigrees of some of the peas, and corn, and snap-dragons, and sugar beets, and bulldogs, and Shorthorn cattle, with which genetists have been working during the last generation; for these humble pedigrees may throw more light on your own than a century of research in purely human material.

BIOLOGY NECESSARY

Your science will not have full meaning and full value to you, unless you bring yourselves to look on men and women as organisms subject to the same laws of heredity and variation as other living things. Biologists were not long ago told that it was essential for them to learn to think like genealogists. It is excellent advice and if I were speaking to biologists I would repeat it. As I am speaking to genealogists, I say with equal conviction that it is essential for genealogists to learn to think like biologists. For the purpose of eugenics, neither science is complete without the other; and I think it is not invidious for me to say that biologists have been quicker to realize this than have genealogists. The Golden Age of your science is yet to come.

(4) In addition to the correction of these faulty methods, there are certain extensions of genealogical method which could advantageously be made without great difficulty, I think.

(a) More written records should be kept, and less dependence placed on oral communication. The obsolescent family Bible, with its chronicle of births, deaths and marriages, is an institution of too great value to be given up, in more ways than one. In the United States, we have not the advantage of much of the machinery of State registration which European genealogy enjoys, and it should be a matter of pride with every family to keep its own archives.

(b) Family trees should be kept in more detail, including all brothers and sisters in every family, no matter at what age they died, and including as many collaterals as possible. This means more work for the genealogist, but the results will repay him.

(c) More family traits should be marked. Those at present recorded are mostly of a social or economic nature, and are of little real significance after the death of their possessor. But the traits of his mind and body are likely to go on to his descendants indefinitely. These are the facts of his life on which we should focus our attention. How this can be most conveniently done, I shall discuss later.

(d) More pictorial data should be added. Photographs of the members of the family, at all ages, should be carefully preserved. They are often of inestimable value. Measurements equally deserve attention. The door jamb is not a satisfactory place for recording the heights of children, particularly in this day when real estate so often changes hands. Complete anthropometric measurements, such as every member of the Young Men's Christian Association, most college students, and many other people are obliged to undergo once or periodically, should be placed on file.

(e) Pedigrees should be traced upward from a living individual, rather than downward from some hero long since dead. Of course, the ideal method would be to combine these two, or to keep duplicate pedigrees, one a table of ascendants and the other of descendants, in the same stock. This plan is not too laborious to use, in many cases; the combined tables, which show all the relatives of an individual, although attractive to the investigator, are too

complicated ever to become popular, I suspect.

THE IDEAL GENEALOGY

Genealogical data of the kind we need, however, can not be reduced to a mere table or family tree. The ideal genealogy, as described by Davenport,[2] starts with a whole fraternity—the individual who is making it, and all his brothers or sisters. It describes fully each member of this fraternity. "It then describes each member of the fraternity to which the father belongs and gives some account of their consorts (if married) and their children. It does the same for the maternal fraternity. Next it considers the fraternity to which the father's father belongs, considers their consorts, their children and grandchildren, and it does the same for the fraternities to which the father's mother belongs. If possible, earlier generations are to be similarly treated. It were more significant thus to study in detail the behavior of all the available product of the germ-plasms involved in the makeup of the first fraternity than to weld a chain or two of links through six or seven generations. A genealogy constructed on such a plan would give a clear picture of heredity, would be useful for the prediction of the characteristics of the generations yet unborn, and would, indeed, aid in bringing about better matings."

(5) With these changes, genealogy would become the study of heredity, rather than the study of lineage. Perhaps you will not all agree that this would be a desirable change; but I think if you can once get the biological, the eugenic point of view, you will realize that any other field for genealogy is too narrow.

I do not mean to say that the study of heredity is nothing more than applied genealogy. As we understand it nowadays, it includes mathematical and biological territory which must always be foreign to genealogy. I should prefer to put it this way: That in so far as Man in concerned, heredity is the interpretation of genealogy, and eugenics the application of heredity. But I do mean to say that genealogy should give its students a vision of the species as a great group of ever-changing, inter-related organisms, a great network originating in the obscurity of the past, stretching forward into the obscurity of the future, every individual in it organically related to every other, and all of them the heritors of the past in a very real sense.

No one is so well fitted as the genealogist to realize the solemn grandeur of Weissmann's doctrine that the germplasm is continuous from the beginning of existence on this world to the now unseen end. Our bodies, as you all have heard, are made up of two parts: this mass of highly differentiated cells which represent the man or woman, and which are destined to die when the individual shall have completed his three score years and ten, more or less; and within, the little mass of germ-cells, the undifferentiated, immortal or at least potentially immortal carriers of the heritage of the race. Generation after generation this germ-plasm goes on dividing; from parent to child it is passed on, unchanged save by the addition at each generation of a new line from the second parent. The body dies, but if the individual has left posterity, the germ-plasm lives after him. Immortality is, in this sense at least, a very real thing to the biologist; and I believe the genealogist would see a new meaning in his work if he kept the same conception in mind.

IMPORTANCE OF INDIVIDUALS

Genealogy does well in giving a realization of the importance of the family, but it errs if it bases this teaching altogether on the family pride in some remote ancestor who, even though he bore the family name and was a prodigy of virtues, probably counts for very little in the individual's makeup today. Let me take a concrete though wholly imaginary illustration: what man would not feel a certain satisfaction in being a lineal descendant of George Washington? And yet, if we place the

[2] Davenport, C. B. Heredity in Relation to Eugenics, p. 240. New York, Henry Holt & Co., 1911.

Father of his Country at only four removes from the living individual, nothing is more certain than that our hypothetical living individual had fifteen other ancestors in George Washington's generation, any one of whom may play as great or greater a part in his ancestry; and so remote are they all that, on statistical grounds alone, it is calculated[3] that the contribution of George Washington to the ancestry of our hypothetical living individual would be perhaps not more than one-third of 1% of the total.

I do not mean to disparage descent from a famous man or woman. It is a matter of legitimate pride and congratulation. But claims for respect made on that ground alone are, from a biological point of view, usually contemptible, if the hero is several generations removed. What Sir Francis Galton wrote of the peers of England may, with slight reserves, be given general application to the descendants of famous people:

"An old peerage is a valueless title to natural gifts, except so far as it may have been furbished up by a succession of wise intermarriages. . . . I cannot think of any claim to respect, put forward in modern days, that is so entirely an imposture as that made by a peer on the ground of descent, who has neither been nobly educated, nor has any eminent kinsman within three degrees."

But, some one may protest, am I not shattering the very edifice of which I am a professed defender, in thus denying the force of heredity? Not at all. I wish merely to emphasize that a man has sixteen great-grandparents, instead of one, and that we too often overlook those in the maternal lines, although from a biological point of view they are every bit as important as those in the paternal lines. And I wish further to emphasize the point that it is the near relatives who, on the whole, represent what we are. The great family which for a generation or two makes unwise marriages, must live on its past reputation and see the work of the world done and the prizes carried away by the children of wiser matings. No family can maintain its place merely by the power of inertia. Every marriage that a member of the family makes is a matter of vital concern to the future of the family: and this is one of the lessons which a broad science of genealogy should inculcate in every youth.

QUALIFICATIONS FOR WORK

Is it practicable to direct genealogy on this slightly different line? As to that, I must allow you to judge; it would be presumptuous for me to express an opinion. Let me recall, however, the qualifications which old Professor William Chauncey Fowler laid down[5] as essential for a successful genealogist:

Love of kindred.
Love of investigation.
Active imagination.

[3] Galton's Law of Ancestral Heredity (which is purely statistical in nature and may be quite misleading when applied to individual cases) makes it possible to calculate the contribution of each ancestor, all the way to infinity. Pearson has modified this law, but as I cite it here only by way of illustration, I give Galton's original version for the sake of simplicity. Following is the calculation for the first six generations:

Generations	Number of Ancestors	Influence of Generation	Influence of Individual
1	2	50.	25.
2	4	25.	6.25
3	8	12.5	1.56
4	16	6.25	0.39
5	32	3.125	0.10
6	64	1.5625	0.024

[4] Galton, Francis. Hereditary Genius, p. 87. London, The Macmillan Company, 1869.
[5] Fowler, William Chauncey. Conditions of Success in Genealogical Investigations. N. E. Hist. and Gen. Soc., Boston, 1866.

Sound and disciplined judgment.
Conscientious regard to truth.
A retentive memory.
A pleasing style as a writer.

With such qualifications, one can go far, and I venture to express the opinion that one who possesses them has only to fix his attention upon the biological aspect of genealogy, to become convinced that his science is only part of a science, as long as it ignores eugenics. After all, nothing more is necessary than a slight change in the point of view; and if genealogists can adopt this new point of view, can add to their equipment some familiarity with the fundamental principles of biology as they apply to man and are laid down in the science of eugenics, I am firmly of the conviction that the value of the science of genealogy to the world will be increased at least five-fold within a generation.

Let us examine a little more closely what can be expected from a genealogy with eugenic foundation.

First and foremost, it will give genetics a chance to advance with rapidity, in its study of man. Genetics, the study of heredity, cannot successfully proceed by direct observation in the human species as it does with plants and rapidly-breeding animals because the generations are too long. Less than three generations are of little value for our researches, and even three can rarely be observed to advantage by any one person. Therefore, second-hand information must be used. So far, we have gained most of this by sending field-workers—a new kind of genealogist—out among the people in whom we are interested, and having them collect the information we wanted, either by study of extant records, or by word of mouth. But the written records of value have been usually negligible in quantity, and oral communication has therefore been our mainstay. It has not been wholly satisfactory. Few people—aside from genealogists—can give even the names of all their great-grandparents, far less can they tell anything of importance about them.

It is thus to genealogy that we are driven. Unless we have family records we can accomplish little. And we cannot get these family records unless you genealogists realize the importance of furnishing them; for as I have already pointed out, and as I wish to emphasize, genealogies at present available are of little value to genetics, because of the inadequacy of the data they furnish. It is only in the case of exceptional families, such as the royal houses of Europe, that enough information is given about each individual to furnish an opportunity for analysis. What could be done if there were more such data available is brilliantly illustrated by the investigation[6] of Dr. Frederick Adams Woods of Boston of the reigning houses of Europe. I commend his writings to every genealogist, as a source of inspiration as well as information.

HOPE FOR QUICK RESULTS

To get more such data, we must look to the future. We must begin at once to keep our family records in such a way that they will be of the greatest value possible—that they will serve not only family pride, but bigger purposes. It will not take long to get together a large number of family histories, in which the idea will be to tell as much as possible, instead of as little as possible, about every individual mentioned. Let me run over a few of the problems on which such genealogies would throw light.

There is the important problem of the inheritance of longevity. Karl Pearson showed[7] some years ago, by advanced statistical methods, that longevity is inheritable. Dr. Alexander Graham Bell, whose investigation of the ancestry of congenital deaf persons at Martha's Vineyard and elsewhere, more than a generation ago, was one of the first pieces of biological genealogy executed in this country, and indubitably estab-

[6] Woods, Frederick Adams. Mental and Moral Heredity in Royalty. New York, Henry Holt & Co., 1906; also The Influence of Monarchs. New York, The Macmillan Co., 1914.

[7] Pearson, Karl. Royal Society of London, Phil. Trans., vol. 192A, p. 277: Biometrika, vol. I, p. 74. London, 1903.

lished the heritable nature of congenital deafness[8]—Dr. Bell is now working on the published history of the Hyde Family in the United States, and analyzing it from many points of view to bring to light the ways in which longevity is inherited. It is obvious that this trait is a particularly easy one for investigation, because we need to know nothing more than the dates on which an individual and his parents were born and died. Certainly a genealogy that does not tell so much, must be considered defective; and yet of the 8,000 or more persons listed in the Hyde genealogy, there are less than 3,000 for whom these data are complete.

Longevity being due more to heredity than to anything else, it is evident, as Dr. Bell has clearly pointed out, that it is a trait of which families may well be proud, if it runs consistently in their stock. And, as we eugenists try as far as possible to put our knowledge to practical use, he has also pointed out that it is very desirable for a young man or young woman to marry into a family possessing that trait, since it is a good indication of general soundness of constitution and physical vigor. Families in whose ancestry longevity is a characteristic can well afford to make the fact known and take pride in alliance with other worthy families similarly endowed.

Such a mating, like with like, is technically known to us as assortative. It used to be supposed that people tended to marry their opposites—the blonde and the brunette, the short and the tall. The use of exact methods in eugenics has demonstrated that the reverse is the case, and that for almost every measurable trait there is distinct evidence of assortative mating.[9] That such a fact is of great value to the race, when the character involved is one of so much importance as longevity, is obvious, and the tendency should be encouraged. Genealogy can give much help in this connection.

There are certain phases of the always interesting problem of sex-determination on which genealogy can easily throw light. It has sometimes been asserted that the age of the parents influences the sex of the offspring. We do not know that this is so, but with the help of genealogy we might find out.

Another question of great practical importance, on which we seek information, relates to the posterity of men of genius. Is there any truth in the idea that their mental activity tends to use up some vital force, with the result that they are either sterile or leave posterity of mediocre quality? The idea does not sound convincing, but we shall not dismiss it dogmatically; we shall appeal to genealogy for data on which to dispose of it definitely. Of course the alleged fact here must not be confused with the well-known fact of regression, formulated as a mathematical law by Galton. We know that, on the average, the children of superior parents will tend to be inferior to their parents, and the children of parents who are below normal will tend to be a little better than their parents. This is due to the vast bulk of their remote ancestry, most of which is necessarily average or, as the statistician puts it, mediocre. The drag of this more remote heredity tends to pull every child toward mediocrity, or the mean, the average of the race. I must emphasize the fact that this is purely a statistical law, applying only to a quantity of cases, and is frequently untrue for individual cases.

The results of early as compared with late marriage offer another big problem, in the solution of which we need your help.

That the first-born children are, on the whole, inferior to the brothers or sisters who come after them has been asserted in recent years, and the assertion has been supported by a good deal of evidence. It is highly important that a much greater body of evidence be brought together on this point, and

[8] Bell, Alexander Graham. Memoir upon the Formation of a Deaf Variety of the Human Race. Washington, D. C., National Academy of Sciences, 1884.

[9] For a summary see Harris, J. Arthur. Assortative Mating in Man. Popular Science Monthly, LXXX, No. 5, pp. 476-493, New York, May, 1912.

here genealogy can aid with very little trouble. Unfortunately, it is not uncommon to find in the earlier generations of a family tree that the exact birth-rank of the various children is not designated; nor is account always made of infant deaths or still-births, as should certainly be done in every case.

The question of consanguineous marriage is one in which every genealogist is certain to have taken an interest, merely because of the doubling up of a name in his chart, if not from a biological point of view. Until recently, the question of the marriage of kin was debated largely by an appeal to dogma. I daresay every genealogist has seen cases where the marriage of first cousins was followed by good progeny, and equally cases where the result was bad. There is plenty of evidence of that sort to be had on both sides. I think it is safe to say that genetics has established the status of consanguineous marriage beyond all dispute. It certainly is not bad in itself, although first cousins are forbidden by law to marry in a third of the States of the Union.[10] It simply results in a doubling up of the traits which the two may have in common. If these traits are good, the children get a double dose of them, and will be more highly endowed than their parents. If the traits are bad, the children equally get a double dose of them, and may far surpass their parents in worthlessness, or in the prominence of any particular defect. The general conclusion is clear to us: marriages between cousins or other relatives of equal consanguinity, should not be condemned offhand, but the facts should be taken into consideration in each individual case. And it should be borne in mind, of course, that a trait may be latent or concealed in each of the cousins, but come into expression in their children. Although cousin marriages, therefore, should be scrutinized closely, we certainly find no reason to forbid them when the contracting parties are of sound stock.

The question of the inheritance of disease is one of great importance, which can be studied very easily through genealogy. Of course, no one with a knowledge of modern work in genetics now believes that diseases are truly inherited as such; but there is a great deal of evidence to show that what the doctors call a "diathesis," a predisposing tendency to some disease, may be inherited. Greater research is urgently needed to find the extent and limits of such inheritance, and it is to enlightened genealogy that we must look for the solution of the problem—or rather, problems, since there are as many problems as there are diseases, defects and abnormalities. We must not draw hasty generalizations, but attack each subject separately. We have pretty good evidence, for instance, that the tubercular diathesis is inherited: that the white plague ravages some families and leaves others untouched; that almost every city-dweller, at least, is at some time or other during his life infected with phthisis, and whether he resists or succumbs depends on his heredity. Herein lies guidance for those who would marry: other things being equal, let them avoid the weak stocks, the stocks known to be marked by tuberculosis. But because tuberculosis is thus a matter of heredity, it does not necessarily follow that cancer, or any other disease, is. We must take nothing for granted; we must find out by examining many families in which a given disease or abnormality occurs. And to do this, we must depend on the data of genealogy.

Here, however, let me utter an emphatic warning against superficial investigation. The medical profession has been particularly hasty, many times, in reporting cases which were assumed to demonstrate heredity. The child was so and so; it was found on inquiry that the father was also so and so: *post hoc, ergo propter hoc*—it must have been heredity. Such a method of investigation is calculated to bring the science of genetics into disrepute, and might easily ruin the credit of the science of genealogy, should genealogy allow itself to be so misled. As a fact, one case counts for practically nothing as

[10] Davenport, C. B. State Laws Limiting Marriage Selection, p. 14. Eugenics Record Office Bull. No. 9, Cold Spring Harbor, Long Island, N. Y., June, 1913.

proof of hereditary influence; even half a dozen or a dozen may be of no significance. There are two ways in which we can analyze genealogical data to deduce biological laws: one is based on the application of higher mathematics to mass statistics, and needs some hundreds of cases to be of value; the other is by pedigree-study, and needs at least three generations of pedigree, usually covering numerous collaterals, to offer any certain results. Not all the findings announced even by professional eugenists have met one or other of these requirements, and to the extent in which they have fallen short, they are being discredited. It is not to be supposed that anyone with a sufficiently complete record of his own ancestry would necessarily be able by inspection to deduce from it any important contribution to science. But if enough complete family records are made available, the professional genetist can be called into coöperation, can supplement the human record with his knowledge of the results achieved by carefully controlled animal and plant breeding, and between them, the genealogist and the eugenist can in most cases arrive at the truth. That such truth is of the highest importance to any family, and equally to society as a whole, must be evident.

SEX-LINKED INHERITANCE

The whole question of sex-linked inheritance depends for its solution on the extension of genealogical material. It is often said that sons take after their mothers, while daughters tend to resemble their fathers. The Arabs and Hebrews put the same idea a little differently, that a son tends to resemble his maternal uncle. Is there anything in these ideas? In a small way, there is no mystery about it; we know that certain hereditary traits are sex-linked—that they *are carried by* one sex but *appear* in the other. Thus, it is rare to find women who are color blind, but a woman who does not show this defect herself may have inherited it from her father, who was visibly affected, and transmit it to her sons, who will also be visibly affected. Extending this principle, it is easy to see that a boy might inherit some traits from his mother, which his father wholly lacked, and that a daughter might similarly receive exclusive traits from her father. I must say that sex-linked heredity in the human race has so far been definitely proved only in regard to color-blindness, hemophilia, and a few other abnormal conditions; but with the coöperation of the genealogists it is probable that we will find this condition, as important as it is interesting, to prevail more widely.

The problem of the inheritance of fecundity can obviously be settled only through proper genealogical material. It is known that fecundity is to some extent an inherited character, although doubtless affected in Man largely by outward circumstances. The voluntary limitation of births, which has become so widespread during the last generation, of course complicates the study of this subject, but there is nevertheless room for much work of a distinctly practical kind. Obviously, one of the easiest ways to improve the general average of the race would be to have high fecundity in the superior stocks and low fecundity in the inferior ones. It is equally obvious that if fecundity is associated with inferiority—with feeble-mindedness, for example,–that disastrous results will ensue if Nature is allowed to "take its course." The genealogist can contribute indispensable material for this study, and for the general study of the birth-rate in various sections of the community at various periods—a study which is the very foundation of applied eugenics.

Frederick S. Crum's work[11] on published genealogies of New England families shows what can be done in this line. From his material, Crum was able to get figures for 12,722 wives, and he found that the number of children per wife had decreased as follows:

1750-1799	6.43
1800-1849	4.94
1850-1869	3.47
1870-1879	2.77

[11] Crum, Frederick S. The Decadence of the Native American Stock. Quarterly Pub. American Statistical Assn., XIV, n. s. 107, pp. 215-223. Sept., 1914.

Before 1700, less than 2% of the wives had only one child each; nowadays the percentage is about 20. The percentage of wives, in his records, who are absolutely childless, has increased as follows:

1750-1799	1.88
1800-1849	4.07
1850-1869	5.91
1870-1879	8.10

He finds, on analysis of the most recent material, that the New England wives of the present day, representing the old colonial stock, have an average of 1.92 living children each, while the foreign-born mothers in the same districts have 3.01. We are accustomed to point with pity at France as a nation committing race suicide, with more deaths than births; as a fact, the old American stock in New England is dying out more rapidly, through race suicide, than is the population of France. Unless a change takes place, the stock which has furnished most of the genealogies and a large part of the great men and women of America is doomed to perish.

The inheritance of the tendency to produce twins is an interesting trait, not without practical as well as theoretical importance, which could probably be solved were a sufficient number of well-kept family trees made available for study. It is known that twinning is largely a matter of heredity, although the exact manner in which the tendency is inherited is still obscure. A good example of the danger of hasty generalization is furnished by the announcement made by some enthusiastic investigator a few years ago[12] that he had found a number of cases which made it evident to him that the tendency to twinning was due to the father rather than the mother. As ordinary twins are due to the production of two ova instead of one, and as the production of ova can hardly be denied to be a function of the mother rather than the father, the claim is absurd. Yet it is possible that a tendency to twinning might be sex-linked and transmitted through a father to his daughters, as has recently been asserted to be the case with high egg production in hens. Whatever the solution may be, it still lies hidden in pedigrees which the genealogist will make, or is already making.

DATA ON ALL TRAITS WANTED

But this list might grow interminably: for properly kept genealogical records will furnish material, without further trouble, for attacking very nearly all the problems in human heredity that are conceivable. The compiler of family histories need only include every physical or mental trait possible, bearing in mind that the genetist will ask two questions about it:

Is this characteristic inherited?

If so, how?

Nor must it be forgotten that we are often as much interested in knowing that a given character is *not* inherited under certain conditions, as that it is.

It is highly desirable that genealogists should acquire the habit of stating the traits of their subjects in quantitative terms. We are too often told that a certain amount is "much;" what we want to know is *how much*. Thus, instead of saying that an individual had fairly good health, tell exactly what diseases he had during his lifetime; instead of remarking that he was a good mathematician, tell us some anecdote or fact that will allow us to judge the extent of his ability in this line. Did he keep record of his bank balance in his head instead of on paper? Was he fond of mathematical puzzles? Did he revel in statistics? Was the study of calculus a recreation to him? Did he solve to his own satisfaction the problem of squaring the circle? Such things probably will appear trifles to the genealogist, but to the eugenist they are precious.

Aside from biology, or that phase of it which we call eugenics, genealogy may also serve medicine, jurisprudence, sociology, statistics, and various other sciences as well as the ones which it now serves. But in most cases, such service will have a eugenic aspect. The alliance between eugenics and genealogy is so logical that it cannot be put off much longer.

[12] Cited by Weinberg, W. Methode der Vererbungsforschung beim Menschen. Berliner Klinische Wochenschrift Vol. 49, 1912; No. 14, pp. 646-649 (April 1) and No. 15, pp. 697-701 (April 8).

You may well ask what facilities we have for receiving and using pedigrees such as I have been outlining, if they were made up. You are all, of course, familiar with the repositories which the different patriotic societies, the National Genealogical Society, and similar organizations maintain, as well as the collections of the Library of Congress and other great public institutions. Anything deposited in such a place can be found by the investigators, mostly attached to colleges and universities, who are actively engaged in eugenic research.

In addition to this, there are certain establishments founded for the sole purpose of analyzing genealogies from a biological or statistical point of view. The first of these was the Galton Laboratory of the University of London, directed by Karl Pearson. I shall not take time to mention the European institutions, but shall call to your attention the two at work in the United States.

The larger is the Eugenics Record Office at Cold Spring Harbor, Long Island, New York, directed by Dr. Charles B. Davenport, and maintained largely through the generosity of Mrs. E. H. Harriman. Blank schedules are sent to all applicants, in which the pedigree of an individual may be easily set down, with reference particularly to the traits of eugenic importance. When desired, the office will send duplicate schedules, one of which may be retained by the applicant for his own files. The schedules filed at the Eugenics Record Office are treated as absolutely confidential, access to them being given only to accredited investigators.

The second institution of this kind is the Genealogical Record Office, founded and directed by Dr. Alexander Graham Bell at 1601 Thirty-fifth Street NW., Washington D. C. This devotes itself solely to the collection of data regarding longevity, and sends out schedules to all those in whose families there have been individuals attaining the age of 80 or over. It welcomes correspondence on the subject from all who know of cases of long life, and endeavors to put the particulars on record, especially with reference to the ancestry and habits of the long-lived individual.

DUTY OF THE INDIVIDUAL

Persons intelligently interested in their ancestry might well consider it a duty to society, and to their own posterity, to send for one of the Eugenics Record Office schedules, fill it out and place it on file there, and to do the same with the Genealogical Record Office, if they are so fortunate as to come of a stock characterized by longevity. The filling out of these schedules would be likely to lead to a new viewpoint of genealogy; and when this viewpoint is once gained, I am satisfied that the student will find it adds immensely to his interest in his pursuit.

You are all familiar with the charge of long-standing, that genealogy is a subject of no use, a fad of a privileged class. I do not need to tell you that such a charge is untrue. But I think that genealogy can be made a much more useful science than it now is, and that it will be at the same time more interesting to its followers, if it ceases to look on itself as an end in itself, or solely as a minister to family pride. I hope to see it look on itself as a handmaid of evolution, just as other sciences are coming to do; I hope to see it link arms with the great biological movement of the present day; I hope to see the two of them working in close harmony, for the betterment of mankind.

So much for the science as a whole. What can the individual do? Nothing better than to broaden his out-look so that he may view his family not as an exclusive entity, centered in a name, dependent on some illustrious man or men of the past; but rather as an integral part of the great fabric of human life, its warp and woof continuous from the dawn of creation and criss-crossed at each generation. When he gets this vision, he will desire to make his family tree as full as possible, to include his collaterals, to note every trait which he can find on record, to preserve the photographs and measurements of his own contemporaries, and

to take a pride in feeling that the history of his family is a contribution to human knowledge, as well as to the pride of the family.

If the individual genealogist does this, the science of genealogy will become a splendid servant of the whole race, and its influence, not confined to a few, will be felt by all, as a positive, dynamic force helping them to lead more worthy lives in the short span allotted to them, and helping them to leave more worthy posterity to carry on the names they bore and the sacred thread of immortality, of which they were for a time the custodians.[13]

[13] Since the above was written, the Eugenics Record Office has published Bulletin No. 13 on "How to Make a Eugenical Family Study." It gives details of procedure which will be of much help to any one interested in eugenic genealogy.

Big Tree Photograph Contest

Because of the large number of entries received at the close of the Big Tree photograph contest (more than 200 arriving during the final ten days of the offer), the Association officials were unable to make an announcement of the result, in time for this issue. The full results will be printed in the September issue.

Stammering and Heredity

Stammering is largely due to heredity, according to Dr. G. Hudson Makuen, who presents a study of 1,000 cases in the *Volta Review* (July, 1915).

"Thirty-nine per cent. of my patients," he says, "admitted having or having had relatives who stammered, and this percentage is probably too low, because there is always a tendency to conceal the facts in matters of this sort, and because stammering probably existed in some of the families without the knowledge of the patients.

"Stammering is an affection that develops with the development of the speech of the individual, and it develops chiefly in those children who have inherited, or it may be acquired, the physical anomalies which make the development of the affection possible or even probable. These anomalous cerebral conditions which give rise to stammering may be transmitted from parents who themselves may not have stammered, but who possessed all the cortical conditions which usually result in the affection and only escaped it through more favorable environmental surroundings."

Inheritability of Cancer in Mice

Cancer in mice is due to the inheritance of a tendency or "diathesis" which behaves as a Mendelian recessive, according to Maud Slye (*Journal of Medical Research*, XXXII, 1, March, 1915). "Among over 9,000 autopsies, yielding more than 500 cases of spontaneous cancer in this laboratory (Otto S. A. Sprague Memorial Institute, University of Chicago), the cancers almost without exception have occurred in strains of known cancerous ancestry." Some evidence is offered that this regular appearance of the disease in certain strains, and not in others, cannot be due to infection. It is stated that mouse cancer is not distinguishable from human cancer. The author concludes, "Cancer is not transmitted as such, but rather as a tendency to occur from a given provocation, probably in the form of over-irritation. The elimination as far as possible of all forms of over-irritation to the tissues of an individual of high cancer ancestry should go far to eliminate the provocation of cancer; and the eugenic control of matings so that cancer shall at least not be potential in both sides of the hybrid cross ought to eventuate in a considerable decrease in the frequency of human cancer."

THE SOUTH AMERICAN TRAVELER'S PALM

View in the botanic garden of Rio de Janeiro, Brazil, showing at the left several tall, fan-like specimens of the South American Traveler's Palm (*Ravenala guianensis*), a relative of the banana. The palm derives its name from the fact that rain water collects at the bases of the leaves, where the thirsty traveler is said to find and drink it, when no other source is available. The account is more picturesque than true, perhaps, since the plant grows only in regions which are naturally well watered, and since the water which does collect at the base of the leaves is usually putrid and full of mosquito larvae. At the right of the photograph is a graceful specimen of Acrocomia, one of the most beautiful of the native South American palms. (Fig.17.)

The

Journal of Heredity

(Formerly the American Breeders' Magazine)

Vol. VI, No. 9 — September, 1915

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The Journal of Heredity is published monthly by the American Genetic Association (formerly called the American Breeders' Association) for the benefit of its members. Canadian members who desire to receive it should send 25 cents a year, in addition to their regular membership dues of $2, because of additional postage on the magazine; foreign members pay 50 cents extra for the same reason. Subscription price to non-members, $2.00 a year, foreign postage extra; price of single copies, 25 cents.

Entered as second-class matter February 24, 1915, at the postoffice at Washington, D. C., under the act of August 24, 1912.

Date of issue of this number, August 26, 1915.

LARGEST TREE FOUND BY THIS ASSOCIATION

Sycamore, buttonwood or plane tree (*Platanus occidentalis*) near Worthington, Ind., by a big margin the largest tree submitted in response to the American Genetic Association's offer of prizes for photographs. It is 42 feet 3 inches in circumference and about 140 feet high. Barring conifers, among which the California Sequoias defy competition, the sycamore probably reaches a larger size than any other tree in North America; and although reports of bigger trees are from time to time made, this association has been unable to get authentic record of any specimen which equals the Worthington tree in size. Its age is unknown, but "oldest inhabitants" declare it has not increased perceptibly in size in the last sixty years. (Frontispiece.)

[See "Photographs of Large Trees," p. 407.]

COLOR IN COCKER SPANIELS

Study of Eighty-nine Matings Shows Numerous Correlations in Colór and Indicates That Inheritance Is Along Same Lines as in Pointer Dogs—Analogies in Other Breeds

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and

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ONE of the few serious pieces of research work on the inheritance of coat color in dogs is that reported in this journal last year by C. C. Little. He showed[1] that in Pointers, black, brown (liver), and yellow (lemon, orange and tan) are inherited in true Mendelian fashion, segregation showing the colors to be due to two factors.

Little's data were from the American Kennel Club records. The authors of this article have utilized private records,[2] comprising eighty-nine matings; in each case the record includes the names and colors of the grandparents, parents and offspring. With this material, we tested Little's conclusions, to see to what extent, if any, they hold good for Cocker Spaniel dogs.

It is, perhaps, worth emphasizing that our records include every pup born in a litter, whether these dogs were later registered or not. Dogs are included here that are in some cases considered undesirable from the breeders standpoint, and would not ordinarily be shown or recorded. To the genetist, this is naturally a distinct advantage, and makes private records rather more trustworthy than stud- or herd-book records on which most investigators are obliged to rely. And as we were personally acquainted with the owners of the dogs, we were able to take every possible precaution to ensure accuracy in the records and descriptions of the colors. For these reasons we feel that, although the total number of matings studied is not large, the results are worthy of confidence.

The colors of Cocker Spaniels are ordinarily spoken of as blacks, livers, reds, and lemons, the reds and lemons corresponding to the yellow colors of Pointers. It is well known that livers may occur in two shades, one a dark chestnut, the other a lighter, more faded liver color. The reds vary from mahogany to lemon, through the red and orange shades. The colors known as lemons are difficult to distinguish from the reds, in fact a good many reds are registered in the Kennel Records as lemon, and some lemons as red. The lemon color may be a brilliant lemon or dull buff, almost without lustre. In distinguishing red and lemon the final test is the color of the offspring when the doubtful animal is mated with a recognized lemon. As a rule a lemon pup is cream or white at birth, and becomes darker with age, while a red shows considerable color at birth.

Our method in attempting to determine whether or not the scheme suggested by Little would hold for Cocker Spaniels was as follows: a table was constructed to show what results might be expected when a dog of any color type was crossed with a bitch of any color type. This arrangement is re-

[1] Coat Color in Pointer Dogs, Journal of Heredity, Vol. V, no. 6, pp. 244–248; June, 1914.

[2] The largest number of records are from the Scioto Kennels. Others were furnished by O. B. Hark, Mrs. M. G. Faber, Mrs. Bonner, Mrs. Walls, F. E. Curtis and Mrs. F. J. Frank. We take this opportunity to thank them for their interest and help in this study.

CHAMPION FRANZA

A good specimen of the black and tan bicolor Cocker Spaniel, with typical markings, owned by the Daffodil Farm Kennels (Mrs. F. J. Frank). From a genetic point of view, this color combination is to be looked on as due to a pattern-factor which allows a lighter (lemon) color to show on certain well-defined areas of the body. The bicolor combination is certainly recessive, so when two black and tan animals are mated, they should always produce bicolor spotted dogs, never any solid-colored ones. (Fig. 1.)

	Zygotes	Gametes	Class 1 BLACK	Class 2 BLACK	Class 3 BLACK	Class 4 BLACK	Class 5 LIVER	Class 6 LIVER	Class 7 RED	Class 8 RED	Class 9 YELLOW OR LEMON
Zygotes			BE BE	BE Be	BE bE	BE be	bE bE	be bE	Be Be	Be be	be be
Gametes			BE | BE	BE | Be	BE | bE	Be bE / BE be	bE | bE	be | bE	Be | Be	Be | be	be | be
Class 1 BLACK	BE BE	BE BE	B	B	B	B	B	B	B	B	B
Class 2 BLACK	BE Be	BE Be		3B 1R	B	3B 1R	B	3B 1R	1B 1R	1B 1R	1B 1R
Class 3 BLACK	BE bE	BE bE			3B 1L	3B 1L	1B 1L	1B 1L	B	3B 1L	1B 1L
Class 4 BLACK	BE be	BE Be bE be				9B 3R 3L 1Y	1B 1L	3B 1R 3L 1Y	1B 1R	3B 3R 1L 1Y	1B 1R 1L 1Y
Class 5 LIVER	bE bE	bE bE					L	L	B	1B 1L	L
Class 6 LIVER	be bE	be bE						3L 1Y	1B 1R	1B 1R 1L 1Y	1L 1Y
Class 7 RED	Be Be	Be Be							R	R	R
Class 8 RED	Be Be	be be								3R 1Y	1R 1Y
Class 9 YELLOW OR LEMON	be be	be be									Y

BREEDING COCKER SPANIELS BY ALGEBRA

Table I, for determination of average results to be obtained by interbreeding the different colors of Cocker Spaniels. To use table, first determine the class to which each dog belongs and then trace the columns to the square in which they meet. Here the colors to be expected and their average relative numbers will be found. A single large letter in the square indicates that the entire litter will be of that color. B = black, R = red, L = liver or chocolate, and Y = lemon. The class to which a given dog belongs can in some cases be determined by a careful analysis of the pedigree and its color, in others by the results of a previous mating. Or the procedure may be reversed. To determine the class of any animal examine a litter the result of mating with another animal, preferably of another color. The determination of the class of two black parents is the most difficult and several other matings may be necessary before an accurate determination is made.

produced herewith as Table I. A glance at the table will show that, using Little's formulae in which BE represents the essentials of the black color type, there will be four possible kinds of black dogs. These are BE BE, BE Be, BE bE, BE be, and will be mentioned as classes 1, 2, 3, and 4 respectively. So far as we have been able to learn there is no way to determine accurately, from the external appearance, to which class a given black dog may belong. However, rusty black dogs do not belong to class 1. Two classes of livers will be noted, bE bE, and bE be, classes 5 and 6. Two kinds of reds Be Be, and Be be, classes 7 and 8, are found; but only one kind of lemon, be be, class 9, can occur.

The red colors of Cockers seem to differ from the yellows of Pointers in being usually very clearly red, not yellow. For convenience we will hereafter speak of the different color types of dogs by giving their class numbers as they are shown in the table. Table I was next used by taking the individual pedigrees and determining from them the class to which each dog belongs; for example, Lucky is known to be of class 3, that is, he has the formula BE Be. He should be found to have the same formula judging by his offspring no matter to what color of bitch he was mated. In this particular case we have found in the records that Lucky belongs to class 3. We have records of nine of his matings, five times to females

	1	2	3	4	5	6	7	8	9
1		11B (2)	11B (1)				11B (2)	10B (2) 7B (1)	
2			8 B (1)	10B 5P (2)			7 B 6 R (4)	19B 13R (7)	
3			10B 3L (2)	36B 12L (10)			23 B (4)	10 B 3 L (3)	
4				3 B 1 R (1)			3 B 2 R (1)	13B 3R 7L 2Y (5)	
5							8 B (1)		
6						3 L 1 Y (1)	9 B 5 R (2)	3 B 2 L 2 R (1)	
7							7 R (1)	39R (10)	
8								18 R 5Y (3)	3 R 1 Y (1)
9									

HOW EXPECTATION WAS FULFILLED

Table II shows the results of crossing various types of Cocker Spaniels, made up from the records of matings furnished to the authors, and based on Table I. Only those matings are here shown in which the formula (class) of each parent is known from two or more matings, B = black, R = red, L = liver, Y = lemon or yellow. Figures in parenthesis indicate the number litters.

of class 3 or 4, three times to class 7, and once to class 8. The results of the first five matings gave thirty-six blacks and twelve livers, an exact agreement with the table. The next three matings, (classes 3 by 7) yielded fifteen black pups. The last mentioned cross (3 by 8) gave four blacks and one liver. In this list each of the red bitches of class 7 was mated more than once and in each mating behaved as a class 7 should, no discordant results being obtained.

We have now double-checked each individual which occurs in two or more matings, and find that the records show the actual existence of each of the nine classes represented, and that with two exceptions the results accord with those expected from Table I. Table II shows part of our actual records.

A comparison of this table with Table I will show that the results agree very closely with those expected. The litter shown as a result of the mating of class 4 by class 4 is placed here because the sire when mated to a red of class 8 gave four blacks and one liver. The only possible arrangement of these litters is to class one as 4 by 4 and the other as 4 by 8. This is, perhaps, the most questionable case given in the table. We have no records of the matings of liver to liver. But Rev. T. Moore-Smith, an extensive breeder of Irish Water Spaniels, writes us that they always breed true in his kennel, and so their formula is probably bE bE, and they represent the mating 5 by 5.

The litter shown as a result of two livers (6 by 6) is a litter of English Water Spaniels. However, there is probably very little objection to its inclusion since at one time both English and Irish Water Spaniels were freely bred with the Cocker Spaniels.

Out of eighty-nine litters there were two which could not be fitted into the table. A red dog of class 8 was sup-

CHAMPION MEPAL'S THE JUDGE

By examination of pedigree and the results of previous matings, it is known that this red and white Cocker Spaniel has the formula Be Be, and also carries the recessive bicolor factor. On the basis of this information, it will henceforth be possible to predict with fair accuracy the kind of pups that will be produced from his mating with any female of known genetic makeup. If the latter is red, yellow or lemon, all the pups should be, without exception, red. Photograph from H. K. Bloodgood's Mepal Kennels. (Fig. 2.)

posedly mated to one of class 7. The litter resulting contained one red, one *liver*, and one lemon. It was recognized at once that for two reds to produce anything but red or lemon was decidedly out of the ordinary. Our data shows that in seventeen matings of red by red, eighty-three red or lemon pups resulted. This one exception, then, cannot well offset such clear evidence that red by red gives red or lemon especially when one considers the difficulty of keeping these active little dogs confined when the breeding period lasts from five to twelve days.

The second exception occurs in the cross of a black of class 2 with a black which we may call Bob. The first cross yielded six blacks. The second time that this mating was made its result was four blacks and one red. Taken by themselves these two litters are not necessarily incompatible. Two other matings with Bob show conclusively that he is class 1. Hence the second litter mentioned above was probably not sired by Bob. In this case whelping occurred several days ahead of time. This, taken with some other evidence shows conclusively that the mating was not correctly recorded. The conclusion to be drawn from a comparison of the two tables is, that in Cocker Spaniels the clear colors are inherited in typical Mendelian fashion and can be accurately predicted when the type of the parent is known and due regard is given to the vagaries of chance in fertilization.

CHAMPION SCIOTO TAD POLE

Black and white Cocker Spaniel bitch owned by the Scioto Kennels (Dr. J. McI. Phillips). Her formula has been ascertained to be BE Be, and reference to the table published on another page makes it easy to predict the results of mating her with any kind of dog of the same breed, whose formula is likewise known. Black is a harder color to work with than any other in Cocker Spaniels, because research shows that there are four kinds of black which look alike but breed differently. Furthermore, the presence of white (or "spotting") adds another complication, because it is apparently due to a number of separate factors, which usually act as a unit. As the spotting is usually dominant, we can say at a glance that the pups of this bitch will probably all be spotted, but whether they will be black and white or red and white can only be predicted by complete knowledge of the genetic makeup of the dog with which she will be mated. (Fig. 3.)

DILUTE COLORS

There occurs occasionally among Cockers a dilute color (dilute black), known as blue, and also individuals which appear to be white. Fig. 6 shows Simcoe Purity, one of these whites, owned by Frank E. Curtis. Simcoe Purity was from a solid black sire and a solid red dam. In the same litter were two red females, Doris and Betty. Mr. Curtis describes the productions of whites and blues from these in these words: "I bred Purity to his two litter sisters Doris and Betty and never failed to get one or two pure white pups in every litter, and with one exception they were always strong and healthy. I usually had in each litter what might be called a blue pup (in my opinion a miserable color) the others were either red or black. When Purity was in stud he was bred to outside bitches, but never threw a pure white pup." "Purity's eyes, nose, and foot pads were black."

CHAMPION SCIOTO PHILIP

Red and white Cocker Spaniel owned by Dr. J. McI. Phillips; his formula is known to be Be be, and he also carries the bicolor factor. Mated with a black female of pure ancestry, all the pups will be black; mated with a red female of pure ancestry, all the pups will be red; while if the mating is with a female that likewise carries the bicolor factor, all the pups will be bicolor. Results of the mating can be predicted with fair accuracy in the case of a mating with any other type of Cocker Spaniel. (Fig. 4.)

This single pedigree is mentioned to show that dilute colors do occur, and that the dilution factor is a recessive and becomes visible only occasionally or as a result of inbreeding in a strain which carries it. It seems improbable that the whites mentioned are true albinos. We are inclined to consider them as dilute lemon. Dilute reds are cream in color. The photograph of Simcoe Purity shows a slight darkening which might be due to yellow, invisible to the eye, but accentuated by the photographic plate.

ROAN PATTERN

A mixture of white hairs with the normally colored ones gives rise to the roan colors, of which our records show two litters. In the first a blue roan (black with white hairs) mated with a red spotted gave three black and white pups and two red roans, in the second another blue roan mated with red spotted gave three blue roans, and one liver roan. This is probably a 3 by 8 mating, the roan animal being homozygous for the roan factor. The roan pattern factor is evidently dominant.

SPOTTING

Spotting occurs in two general types, which we shall speak of as ordinary spotting and bicolor spotting. The ordinary spotting is the common condition in which the dog is more or less irregularly marked with patches of black and white, red and white, lemon and white, or liver and white. The spots vary from small breast or face

CHAMPION LUCKY

Black and white Cocker Spaniel owned by Pleasant Hill Kennels (O. B. Hark). Investigation of his pedigree showed that his formula was BE Be (class 3). According to theory, when he is mated with a female of similar genetic makeup, the pups should be 75% black and 25% liver. Five matings of this sort were recorded, and it was found that they resulted in thirty-six blacks and twelve livers—an exact agreement with the calculated total. By the law of chance, the results will not always come so close, when a small number is concerned; but it is evident that much of the uncertainty surrounding dog-breeding will be removed by the use of such Mendelian calculations as are described in the accompanying article. (Fig. 5.)

splashes to the condition in which the dog is largely white, with a few scattered marks of color. The method of inheritance is shown in the accompanying summary of our records.

Spotting is dominant in this case as in most cases so far studied, and is apparently due to multiple factors, which in their most perfect development act as a single factor. The irregularities

Table III

Mating	All Individuals Spotted	Individuals Mixed Spotted and Solid	All Individuals Solid
Spotted by spotted	207 (30 litters)	13 10 (5 litters)	4 (1 litter)
Spotted by solid	18 (3 litters)	49 45 (12 litters)	13 (2 litters)
Solid by solid	2 (very small spots on breast) (1 litter)	....	19 (2 litters)

SIMCOE PURITY, A WHITE COCKER SPANIEL

A valuable "sport" in the breed is this dog, produced in the Simcoe kennels of F. E. Curtis, Simcoe, Ontario, Canada. He is the offspring of a solid black dog and a solid red bitch. The animal is not an albino, for his nose and foot-pads, as well as eyes, are dark in color. He is probably to be considered a dilute lemon. The value of inbreeding is well illustrated in a case like this: bred to outside females, Purity has produced no white pups, but when mated with his own close relatives a few pups in each litter are white. As a result, a pure white strain, hitherto unknown in the breed, might be established. (Fig. 6.)

in the table probably arise from the curious behavior of the spotting factor in different strains of dogs. If two individuals, which show small spots, coming from a solid color strain, are crossed, half of the resulting offspring are apt to be solid color, while the rest will be spotted. Selection for larger areas of white or color has a cumulative effect, which affects the ratio of spotted to solid offspring.

Another cause of apparent irregularities in the table arises from the fact that a dog showing a breast spot or white on the toes may be classed as a solid color in the kennel records. The two litters of thirteen solid color pups, shown in the last column of the table are from a tricolor mated with a spotted dog. The bicolor pattern factor, which will be described later, seems to have some effect in producing pups of solid color.

The second type of spotting, which we shall call bicolor spotting,[3] is in reality due to a pattern factor which allows a lighter (hypostatic) color to show on certain definite parts of the body. For example the condition most frequently seen is that of a black dog having dark or light red or lemon spots over each eye, and extended red areas distributed on the sides of the muzzle, inside of the ear, posterior surfaces of the legs, and on the ventral sides of the chest, abdomen, and tail. This pattern is most striking when found on dogs showing much black, but it is commonly

See Pocock, R. I., 1907. On the Black-and-Tan Pattern of Domestic Dogs (*Canis familiaris*). Ann. Mag. Nat. Hist., Ser. 7. Vol. 19, pp. 192–194.

met in animals of other colors. Liver colored dogs may be marked with red or lemon, red dogs with lemon. If white occurs along with the bicolor pattern the dog is usually described as tricolor.

The inheritance of this factor is indicated by the following observation: Three matings in which principals are not bicolors or tricolors, but have tricolors among their ancestors, yield twenty-one non-tricolors and three tricolors, as shown in the pedigree below. Among these noted as non-tricolor are probably some red bicolors. When tricolors are crossed with non-tricolors which come from strains not showing the bicolor or tricolor patterns there result only plain colored offspring. However in two cases where tricolors were crossed with non-tricolors from strains containing the tricolor factors there occurred seven non-tricolor and three tricolor offspring.

The bicolor factor is certainly recessive. Certain combinations should always produce tricolors. For example a tricolor of class 2 mated with a liver and white of class 5 which shows the buff marks should produce litters consisting exclusively of black tricolors. Several similar matings are possible, as can be seen from the table. We know of no such mating, but it should be an easy matter to test this hypothesis.

The tricolor markings with the hypostatic colors are limited, in the following breeds, to the same areas as in Cockers; Dachshunde, Toy Black and Tans, Manchester Terriers, Gordon Setters, King Charles and Prince Charles Spaniels, some Fox Terriers, Pointers, Beagles and Collies. The combination of red with lemon marks is more often found in Collies than in any other breed.

In certain Fox Terriers and Beagles the tan extends further up on the legs, and over the face, until the black is limited to the ears, the upper part of the occiput, and over the back and sides. In the Welsh Terriers this distribution of color is the usual one. In the Airedale the black is limited to a saddle commencing at the withers and extending over the back, tail and sides. All of these markings are probably due to the same pattern factor which we call bicolor in Cockers.

This pedigree was sent to us by one of our correspondents, as an example of the absolutely unpredictable nature of the heredity of colors in Cocker Spaniels! The solid red parent is evidently of class 8, while the liver and white parent is of class 6. The presence of a tricolor pup, and the fact that approximately half of the pups were spotted makes the pedigree most interesting. We shall leave it to the reader to decide whether or not the results of this mating could have been predicted with fair accuracy.

In this mating the number of lemons is insufficient. One of those noted as red may be, in reality, a lemon. In our records lemon seems to occur less often

Black
Liver and white
Orange and white
Red (solid)
Black
Black, white and orange marks, (tricolor).
Black
Black
Liver and white
Black
Liver and white
Black
Liver and white
Black, white and orange marks, (tricolor).

1 Liver, 1 liver and white.
1 Red, 1 red and white.
1 Black, 1 black and white.
1 Black and white with orange marks (tricolor).

than it is expected. This lack could be explained by the hypothesis that the gametes containing be are not as active in the fertilization process as those which contain B or E or both.

EYE, FOOT-PAD, AND NOSE COLORS

While we do not have complete records of the eye, foot-pad and nose colors, there are a few general observations which it seems well to add here for the sake of calling attention to the association of these colors.

The eye colors of Cockers range from black through various shades of brown to yellow. The eye color is not necessarily correlated with the coat color, or the color of the nose and foot-pads, except in the case of liver colored individuals where the eye is usually not darker than the coat, and is commonly much lighter. A black or red dog may have black, brown or yellow eyes. As far as our records go they show that the darker colors are epistatic to the lighter ones.

The nose color is always the same as the color of the foot pads. Black dogs always have black noses, while red dogs may have black or brown noses and foot pads, and may also have black spots on the skin which are not associated with colored spots in the coat. Lemon colored dogs may have the nose and foot pads black, brown, or a dusky pink. Chocolate colored dogs always have chocolate nose and foot pads. It is clear that the red animal can produce black pigment in the skin and eye but not in the hair, while the chocolate or liver colored individual can produce no black either in the eye or skin.

NEW PUBLICATIONS

THE NEXT GENERATION, by Frederick A. Rhodes, Chairman of the Morals Efficiency Committee of Pittsburgh. Pp. 290, price $1.50 net. Boston, Richard G. Badger, 1915.

Dr. Rhodes has attempted to test a great many social problems by the principles of biology, but his book bears the evidence of being hastily put together from newspaper articles, and is not likely to take rank as a serious contribution to eugenics. Although its scope and general attitude toward race betterment are admirable, the work is marred by a great many errors of fact, and a tendency to substitute quoted opinions of other people for reports of research. It is easy reading, however, and may lead students of the wide range of problems on which he touches to desire further knowledge of what biology has to offer them; in this case it will perform a real service.

Improving the Chile Pepper

The chile pepper (*Capsicum annuum*), so much relished by Mexicans, is the object of attention at the New Mexico Agricultural Experiment Station, where for the last five years it has been improved by selection for larger, smoother, fleshier pods and freedom from blight. Three good strains have been perpetuated from the fifteen with which the experiment started.

Studies in Correlation

Correlation is the principal concern of breeding studies, at the Montana Agricultural Experiment Station, the characters of plants being measured in comparison with those of their parents. Practical breeding of various cereals is also being done.

PLANT BREEDING IN CANADA

Work at Dominion Experimental Farms Begun by Late Dr. William Saunders—Mostly with Apples—Many Hardy Types Produced—Work with Vegetables and Ornamentals.

W. T. Macoun

Dominion Horticulturist, Central Experimental Farm, Ottawa, Canada.

THE breeding of horticultural plants at the Dominion Experimental Farms was begun when the late Dr. Wm. Saunders brought from London, Ont., in 1888, a large collection of bush fruits and grapes which he had accumulated as a result of his work in cross-breeding begun in 1868. Since 1888 a continuous effort has been made to originate new varieties of fruits, vegetables and flowers which would be more useful in some parts of Canada than anything available from other sources. Canada had up to that time depended almost entirely for new varieties of fruits on foreign countries and while this is true to a large extent today, much has been done by the Dominion Experimental Farms to develop new plants. While the main purpose has been to obtain new varieties of commercial value, the possible discovery of underlying principles has been kept constantly in mind.

As the main work in breeding has been with the apple, the greater part of this article will be devoted to giving an account of what has been done with this fruit.

In 1887, seed of the wild Siberian crab apple *Pyrus baccata* was imported from the Royal Botanic Gardens, Petrograd, Russia, and sown at the Central Experimental Farm, Ottawa. Young trees grown from this seed were sent to the Experimental Farms at Brandon, Man., and Indian Head, Sask., in the prairie provinces, where the winters are very severe, the temperature at Indian Head falling at times to 50 below zero, Fahr. These trees proved quite hardy on a practically treeless prairie, while trees of cultivated varieties of crab apples and apples succumbed.

The fruit of this wild crab apple is very small, only half an inch in diameter, and it is quite astringent. In 1894 the late Dr. Wm. Saunders, then Director of the Experimental Farms, began crossing this wild crab apple with named varieties of apples in the hope of obtaining fruits of larger size and better quality than *P. baccata* but which would retain sufficient hardiness to endure the climate of the prairie provinces. All the crosses recorded have *P. baccata* as the mother; reciprocal crosses were not made. One hundred and sixty trees resulted from the first crossing and several hundred from subsequent work, or about 800 in all.

Some of the varieties of apples used as male parents are Tetofsky, Duchess, Wealthy, Anis, Beautiful Arcad, Broad Green, Excelsior, Fameuse, American Golden Russet, Haas, Herren, Krimskoe, McIntosh, McMahan, Osimoe, Pewaukee, Red Astrachan, Ribston, Scott Winter, Simbirsk No. 9, Swayzie, Tolman, Winter St. Lawrence and Yellow Transparent.

In 1899 thirty-six of the first crosses bore fruit and five of them were considered large enough and sufficiently good in quality to be propagated. By far the largest proportion produced fruit not sufficiently larger than the mother parent and of so inferior a quality as to be not worthy of propagation, but sixteen varieties were thought sufficiently promising to name. On weighing average specimens it was found that the best of these were from twelve to fourteen times heavier than the fruit of *P. baccata*. The largest fruits, however, were under 2 inches in diameter.

The better varieties of these crosses have little or no astringency and compare

very favorably in quality with the named crab apples on the market. Nearly all of them retained the marked crab characteristics of long, slender stem; thin, tender skin, and crisp, breaking flesh.

SOME HARDY VARIETIES

After being propagated and thoroughly tested on the prairies some of these have proved hardier than any other varieties of apples or crab apples tested, thus marking a stage of development in hardy apples for the prairie provinces. Some of the hardiest varieties have proved to be Jewel (*P. baccata* by Yellow Transparent, size 1.4 by 1.3 inches), Columbia (*P. baccata* by Broad Green, size 1.8 by 1.6 inches), Charles (*P. baccata* by Tetofsky, size 1.6 by 1.5 inches), Silvia (*P. baccata* by Yellow Transparent, size 1.4 by 1.5 inches), Tony (*P. baccata* by McMahan, size 1.6 by 1.4 inches), Elsa (*P. baccata* by Yellow Transparent, size 1.4 by 1.3 inches), Eve (*P. baccata* by Simbirsk No. 9, size 1.6 by 1.2 inches). Seedlings grown from these gave in nearly every case fruit smaller than the parent. As none of the fruits resulting from this cross was large enough to compare favorably with less hardy varieties of apples and crab apples, the best of these first crosses were, in 1904, recrossed with named varieties of apples with the object of obtaining varieties bearing larger fruits but which would retain sufficient hardiness to be grown in the open on the prairies.

In this work Dr. Saunders used the crosses as the mother parents in all cases. The varieties of apples used as male parents are McIntosh, Baldwin, Cranberry, Duchess, Northern Spy, October, Scott Winter, Simbirsk No. 9, Tetofsky, Yellow Transparent, Ontario, Gideon, Rideau, Haas, August, Walter, Wealthy, McMahan. From seeds obtained through this work 407 trees were grown at Ottawa which began to fruit in 1910 and of which a large proportion have borne. While many of these have borne fruit no larger than the mother parent, 24 have produced apples two inches and more in diameter. Some of the largest varieties which have fruited are Wapella (Dean by Ontario) size 2.25 by 2.25 inches; Angus (Dean by Ontario) size 2 by 2.5 inches. The parentage of Dean is *P. baccata* by Wealthy. Martin (Pioneer by Ontario) size 2.25 by 2.37 inches; Gretna (Pioneer by Northern Spy) 2 by 2.25 inches. The parentage of Pioneer is *P. baccata* by Tetofsky. Most of these second crosses retain the long, slender stem, the thin, tender skin, and the crisp, breaking flesh which are characteristic of *Pyrus baccata*, but a few are quite apple like.

It is not known yet whether these will be sufficiently hardy or not, but this will soon be determined.

It is to be regretted that the apple (*Pyrus malus*) was not used as the mother in these crosses, as it is believed by the writer that larger apples would have been obtained more quickly, but size might have been obtained at the expense of hardiness which is the first consideration on the prairies. If these second crosses prove hardier than any other apples or crab apples which have been tested they will mark another step in advance.

NEWER WORK WITH APPLES

As some of the Russian varieties of apples had proved hardy in certain places in the prairie provinces and had produced considerable quantities of fruit, a new line of breeding hardy apples for the prairies was begun by the writer in 1912. Seed was sown of such hardy varieties as Anis, Anisette, Antonovka, Beautiful Arcad, Blushed Calville, Charlamoff, Hibernal, Tetofsky and Yellow Transparent. After the trees had made one season's growth in the seed bed they were transplanted one foot apart into nursery rows 3 feet apart on the six Experimental Farms at Brandon, Man., Indian Head, Sask., Rosthern, Sask., Scott, Sask., Lacombe, Alta., and Lethbridge, Alta., and a few were sent to a sub-station at Fort Vermilion in the Peace River District. Some 50,000 trees were planted out in this way and it is planned to plant many more. Many of these trees have now passed through three winters and some of them have proved quite hardy, though a marked difference in this respect has

THE SIBERIAN CRAB APPLE

Actual size of the hardy Siberian crab apple (*Pyrus baccata*) which is being used by Canadian government breeders to cross with cultivated apples and produce a type that will be more resistant to the cold of the northern prairies. Some of the hybrids had fairly good flavor, without the astringency of the Siberian crab, but they lacked size, so they were recrossed with cultivated apples. The result is promising, in size and flavor, but it remains to be seen whether the hardiness of the Siberian stock has been retained. (Fig 7.)

been found. The hardy ones are now being transplanted to orchards for further test. It is hoped in this way also to obtain hardy varieties for Canada's coldest climates.

There is a very large area in Canada where the apple succeeds well, but where the range of suitable varieties is limited as up to recent years Canada has depended mainly on foreign conu-

tries for her fruits, and many of the varieties introduced from warm countries have only been suitable for the most favored districts in Canada, hence an effort has been made to obtain other and hardier sorts which will cover the season better. As the Horticultural Division was not organized to do much work in cross-breeding, the writer, in 1898, believing that in an orchard at the Central Experimental Farm containing between 400 and 500 named varieties of apples all sorts of combinations of characters would be taking place by natural pollination and that the chance of obtaining some good varieties would be very great, had seed saved of some of the best flavored apples then fruiting in the orchard as well as some other varieties desirable on account of other characteristics. There were included in these McIntosh, St. Lawrence, Fameuse, Wealthy, Shiawassee, Swayzie, Northern Spy, Winter St. Lawrence, Langford Beauty, Scott Winter, Salome, Lawver, Gano and American Golden Russet.

OPEN-POLLINATION SEEDLINGS

The seedlings from these were planted in the orchard in 1901 and later until about 2,000 were set out, The results from this work have been very gratifying. The first tree to fruit from seed was a Wealthy seedling now called Crusoe which fruited in 1903, two years after planting and five years from seed. Detailed descriptions have been made of the fruit of more than 1,200 of these seedlings. There have been so many good apples among them that 100 varieties have been named because giving promise of being useful in some part of Canada. The male parent was unknown in this series of seedlings, but it is very interesting to note that a large proportion of such seedling varieties from McIntosh, Wealthy, and Northern Spy had characteristics strongly resembling the mother parent, while Fameuse, Swayzie, St. Lawrence and others were lacking in this respect, although in the case of Swayzie the spicy flavor of the mother parent was marked in most of the seedlings. Only about 5% of the seedlings have been small or crab-like. Further details in regard to these seedlings will be found in the reports of the Experimental Farms.

Following are the names of some of the best varieties:

McIntosh Seedlings.—Melba, Joyce, Pedro. These are three apples of the McIntosh type: the Melba, an August apple, the Joyce, a September apple, and the Pedro, an October apple, thus extending the season of apples of this type.

Northern Spy Seedlings.—Autumn: Galton, Epsom, Thurso, Rocket, Tasty. Early winter: Lipton, Ascot. Winter: Elmer, Emilia, Sparta, Niobe.

While it is not claimed for any of these that they are better than Northern Spy or quite as good in most cases, they have all proved hardier than Northern Spy at Ottawa and they give a longer season of apples of the Northern Spy type.

The names might be given of seedlings of other varieties but as McIntosh and Northern Spy are two of the most popular varieties grown, their seedlings are given as examples. Detailed descriptions will be found in the annual reports of the Experimental Farms.

Previous to this series of seedlings, some 3,000 trees raised from seed received from north of Riga in Russia in 1890 had been tested but had given practically nothing of value as the fruit as a rule was of inferior quality.

CROSS-BREEDING APPLES

A little work in cross-breeding was done in the Horticultural Division in 1895 when McMahan was crossed with Scott Winter and Walbridge with Northern Spy, but beginning in 1899 some work has been done almost every year since. The parents used in making crosses are Anis, Anisim, Antonovka, Baldwin, Baxter, Bethel, Bingo, Cobalt, Crusoe, Duchess of Oldenburgh, Dyer, Danville, Fameuse, Forest, Glenton, Gravenstein, Hibernal, Lawver, Lowland Raspberry, Malinda, Milwaukee, McIntosh, McMahan, Newton, Northern Spy, North Western Greening, R. I. Greening, Rosalie, Rouleau, Scott, Winter, Stone, Winter Rose, and Walton. Reciprocal crosses have been made in many cases. There have been two

main objects in view in this work, first to obtain hardier winter apples for the colder parts of Canada where apples are grown commercially and, second, to obtain early bearing varieties covering the whole season, as there seems to be no good reason why more apples of the Northern Spy type should not be obtained which will bear as early as Wealthy and Wagener.

More than 1,000 trees are now growing as a result of a little crossing almost every year and nearly 100 of these have already fruited. So far not many apples have fruited which have been thought worthy of propagation, but there have been a few from a cross between McIntosh and Lawver where the object was to obtain varieties which would keep better than McIntosh.

In six out of ten crosses which have fruited with Lawver as the mother no marked resemblance to either parent is recorded, and similarly in three of the six with McIntosh as the mother. Of the four varieties with Lawver as the mother that have marked characteristics of the parent, two have distinct McIntosh flavor and two resemble McIntosh in color. The Lawver characteristics are not very marked. Of the six varieties with McIntosh as the mother only two show marked resemblance to either parent in the important characteristics of color, flesh, and flavor, although as regards season a large proportion resembles both parents. The McIntosh seedlings from open pollination have given a larger proportion with marked McIntosh characteristics than has been the case in this cross. While there are none of the sixteen varieties of this cross which have yet fruited which are as good as McIntosh in quality, ten of the sixteen are better than Lawver in quality and thirteen of the sixteen are later in season than McIntosh, and most of the varieties are of high colour and attractive in appearance. Following are those which have been named: Lawver by McIntosh-Holz, Vermac. McIntosh by Lawver-Mavis, Rustler.

The new varieties of apples which have been referred to are being tested in different parts of Canada and no doubt some of them some day will take their place among the list of best varieties offered for sale, but their introduction is not being pushed as there are too many already.

WORK WITH OTHER FRUITS

Pears.—Some work has been done in recent years with pears. It has been found that certain Russian varieties such as Bessemianka and Gliva Kurskaya are comparatively immune from fire blight and these have been crossed with other and better varieties.

Plums.—Little cross-breeding has been done but many seedlings have been grown of *Prunus americana* and *P. nigra*, some of which have been named. It is believed that *P. nigra* offers the better field of work as it has more good characteristics for Canadian conditions than *P. americana*.

Cherries.—Seedlings are being grown of a wild cherry from North-Eastern Asia called *Prunus tomentosa*, the fruit of which varies considerably. This is a bush cherry which is hardy where the tree cherries do not succeed. Varieties with better fruit are sought.

Grapes.—Little progress has been made in breeding grapes though many seedlings of Rogers Hybrid grapes are now being grown and it is expected that some good sorts will be obtained.

Gooseberries.—Seedlings are being grown of crosses between *Ribes oxyacanthoides*, *R. cynosbati*, and *R. grossularia* varieties looking to obtaining larger fruited sorts not subject to mildew.

Currants.—A number of seedlings and cross-bred varieties, the best saved from a large number, are being tested out.

Strawberries.—A large number of seedlings have been grown but few good varieties have been obtained. Some of the most promising are Cassandra, Cordelia, Desdemona, Ophelia and Portia. In recent years crosses have been made between wild strawberries obtained from different parts of Canada and cultivated varieties with the object of obtaining hardier sorts.

Early varieties of vegetables are of great importance everywhere, but are

much needed in certain parts of Canada. Selections for earliness have been made with tomatoes, beans, peas and corn particularly. The Alacrity tomato and Early Malcolm corn are two selections which have been most disseminated. During the past two years considerable work has been done in cross-breeding corn, the Squaw (flint), Early Adams (dent), and Early Malcolm (sweet) being mainly used as parents. The Squaw corn matures in districts where the nights are cool and the season without frost is short, whereas sweet varieties will not do so. It is hoped by crossing to obtain sweet varieties which will mature anywhere the Squaw does. Many interesting and promising crosses have been obtained.

Comparatively little work has been done in breeding ornamental plants, but some progress has been made with roses, sweet peas, geraniums, petunias and columbine. Two worthy varieties of roses originated at Ottawa by the late Dr. Wm. Saunders are Mary Arnott and Agnes, the former a brilliant crimson scarlet cross between *Rosa rugosa* and Prince Camille de Rohan, the latter, pale yellow with a salmon tinge, a cross between *Rosa rugosa* and Persian Yellow. Some interesting and attractive F_2 seedlings are growing from a cross made between *Berberis thunbergii* and *Berberis vulgaris purpurea*.

There is a specialist in the Horticultural Division who devotes his whole time to plant breeding.

Plant Breeding in Maryland

Plant breeding at the Maryland Agricultural Experiment Station is on a large scale, both as regards practical problems and the theoretical problems which it is attempting to solve. Mendelism is being investigated in cowpeas, in connection with selection; wheat, oats and barley are being cross-bred and selected, corn is being bred and studied in a series of experiments which has now been under way for ten years, mutations are being systematically sought in the cereals. A new variety of pear of good quality and resistant to blight is sought by crossing, particularly Kieffer by Seckel; apples are being bred in a similar way, to produce a good, early, red apple of good cooking quality. Grape hybrids include most of the hardy American species as well as the Malaga type of southern Europe, *Vitis vinifera*. Strawberries, celery, tomatoes, muskmelons, Irish potatoes, cabbage are also the subjects of projects destined to furnish more productive or disease resistant varieties and also to yield information about the laws of heredity. Finally, the station is doing genetic research with one kind of material which has been very little worked—namely, the castor bean (*Ricinus communis*), where the variation and heredity of individuals propagated from different branches and different flowers is being investigated. The production of ornamental plants, a work usually left to commercial nurserymen, has been undertaken to the extent of breeding improved strains of dahlia and Black Eyed Susan.

Plant Breeding in Michigan

A number of superior varieties of wheat—produced by the isolation of pure lines—have been put in the trade by the Michigan Experiment Station, as have two lines of oats. A study of the inheritance of earliness in oats has been running since 1911. Investigations of a more technical genetic nature are making in corn and wheat. A line of navy beans has been selected which is resisting blight to the extent of 8 or 10 bushels more to the acre than ordinary commercial strains. Alfalfa breeding has been carried through five generations, the object being to produce strains that will not only be hardy and productive in Michigan, with its severe climate, but will bear seed under such conditions. A considerable degree of success has already been attained.

WAR'S AFTERMATH

Survey of Parts of the South Yields Evidence of Biological Injury to Nation through Civil War, with No Evidence of Any Countervailing Effects

Review of a Book by

DAVID STARR JORDAN AND HARVEY ERNEST JORDAN

IT IS fairly obvious to any thinking person that war is a tremendous factor in cacogenics, because it destroys men who are superior—physically, at least— and leaves the relatively inferior to perpetuate the race. Biologists have been calling attention to this fact for many years, but until recently no effort has been made to particularize the indictment of militarism. An attempt has recently been made in this direction, by David Starr Jordan and Harvey Ernest Jordan, working under auspices of the World Peace Foundation. Their results have been published in a little book[1] called "War's Aftermath." This is the first attempt in history to put the postulate that war *reverses* the action of natural selection to the test of actual investigation.

At the very start of the research, there were certain facts available whose meaning could be hardly misinterpreted. It was known that nearly a million young men, largely of superior fitness, had perished in the Civil War, and it was inconceivable that their loss should not have affected the racial stock of the nation. The loss was not unequally divided between North and South; but it represented 2% of the white population of the North, and 10% of the white population of the South. "The Southern loss of human wealth was therefore five times as heavy as in the North, and the results of this loss should be correspondingly more evident. This is in fact the case, although in certain Northern States, as Vermont, Connecticut, Massachusetts, the loss was almost as great relatively to the population as in Virginia or Georgia.

"This loss fell on the men of that part of the community racially most valuable, the young men between the ages of 18 and 35. At least 40% of these in the South died without issue. Even among the Southern States this loss was unequally distributed, Virginia and North Carolina apparently suffering most. Both Virginia and North Carolina were settled mainly by the same British stock, many Scotch being represented and in certain localities the Pennsylvania Germans. The racial quality throughout was high, and it may be assumed to have been about equally high and as good as the best in the United States or in the world, at the time of the outbreak of the war."

EXACT MEASUREMENTS WANTED

Such broad facts were known, but it seemed desirable to make a more intensive study of some small portion of the area most affected, in order to determine the exact nature of the war's aftermath. The investigators knew that *some* racial hurt has been caused; they wanted to find out *how much*. After a careful survey of the field, Rockbridge and Spottsylvania counties, in Virginia, and Cobb county, in Georgia, were chosen as likely to yield the most satisfactory results.

[1] War's Aftermath: a preliminary study of the Eugenics of War, as illustrated by the Civil War of the United States and the late wars in the Balkans; by David Starr Jordan, Chancellor of Stanford University, and Harvey Ernest Jordan, professor of histology and embryology in the University of Virginia. Pp. xxxi+104, price 75 cents net. Boston and New York, Houghton Mifflin Company, 1914.

If the investigators ever imagined that they could get even a rough measurement of the biological effects of the war, they were soon undeceived. The problem was found to be very complicated, even in the favorable localities chosen, and they had to content themselves with getting "approximate results by less direct methods." The data on which their conclusions are based are opinions, almost as much as facts, and were thus secured:

"We took advantage of every opportunity to interview representative men, and especially veterans of the war, on the question at issue. From hundreds of these, valuable information was gleaned. These conversations were crystallized into a set of thirty propositions which were one after another to be tested. These propositions, usually in the words of some thinking veteran, were put into the form of a questionnaire and sent broadcast over the South to the surviving Confederate officers and other men of intelligence, for comment and criticism."

It will be possible in this review only to touch on the propositions of the greatest importance, from a eugenic point of view. It was found that the leading young men of the South, from a social point of view, were mostly members of select companies of militia, at the outbreak of the war; and these were the first to enlist. The loss of life among them was naturally greater than among those who entered the war near its conclusion. "The flower of the people went into the war at the beginning, and of these a large part died before the end." Those who did not fight until conscripted, late in the struggle, were on the average inferior to the volunteers, both in physical and moral qualities. But as the mortality was lower among them than among the superior volunteers, who entered the war earlier, the deterioration in the average quality of the race was increased to the same extent. The deserters, and those who took to the hills to avoid conscription, also survived to multiply. "The result of this was that the men of the highest character and quality bore the brunt of the war and lost more heavily than men of inferior quality. This produced a change in the balance of society by reducing the percentage of the better types without a corresponding reduction of the less desirable types; a condition which was projected into the next generation because the inferiors lived to have progeny and the others did not."

HALF OF BEST BLOOD LOST

It is admitted that the above conclusion may be a little too general and sweeping, but there is reason to believe that a half, perhaps considerably more, of the "best blood" of the South was lost in the war. As to just how good this blood was that was lost, there is no accurate means of judging.

In addition to the loss of men, the birth-rate was likewise affected through changes in the condition of the women. "Widows of soldiers suffered great hardships and most of them never remarried; the death-rate among them was unusually high for the first ten or fifteen years after the war. The sweethearts of many a victim of the war never married; with the elevation of the middle class and the lack of men of their own class many girls of the aristocracy married men beneath them in station." The result stated in the last clause, the authors admit, "is far from a racially unmitigated evil, regarded in a broad and democratic sense," but on the whole the effect of the facts outlined in this paragraph was still further to decrease the production of superior children, in the years following 1865.

When they tried to decide how far, if at all, the present population of the South is inferior to that of antebellum days, the investigators naturally found their way paved with difficulties. There is some reason to believe, it appears, that the farming class is as good as ever. Perhaps "the class of men attending courts does not measure up in intelligence or ideals with those before the war." It is thought that "the public men of the South do not measure up to those of old times," but this condition to a certain extent prevails through the nation. It is admitted that

"after the war the best of the middle class—farm managers and commercial men—rose to equality with the remnants of the old aristocracy," but the statement that "the Civil War destroyed the cream and stirred up the dregs" met with much disapproval, and leads the investigators to say, "There is probably more than a grain of truth in the assertion that the 'poor whites' of the South have never had justice done them. They are much better raw material than is generally supposed."

On the whole, however, and making due allowances for many qualifying and compensating factors, "The men who got themselves killed were the better men."

The authors made an attempt to find whether environmental factors could be charged with part of the blame for the South's present condition. If the lack of great men, or the lowering of ideals, were due to faulty education, or the influx of "carpet-baggers" from the North after the war, or emigration, whisky, or cousin-marriages, then war could to that extent be acquitted of reversing selection and deteriorating the race. It was admitted that some or all of these factors might play a part, but emigration was the only one which seemed to deserve much consideration, and that appears to have affected only limited regions.

Again, it was suggested that although the strong fell first in battle, the weak fell first in camp; so that the balance remained about the same. Even if considerable weight be granted this circumstance, the loss of strong men, who could ill be spared, remains.

SOME BENEFITS SEEN

Some social and economic benefits from the war are suggested. "The South is the better by far for the spread of education, for the willingness to work, for the loss of slavery, for the maintenance of the Union, and for the development of business. But for the war, as war, there was no redeeming feature, no benefit to any one, not one word to be said,"[2] was the last of the propositions submitted to the survivors; and it seems to have won the assent of a large number of them.

"In conclusion," the authors say, "we are impressed that with respect to the eugenic aspect of the Civil War we are dealing with matters insusceptible of precise determination. Many factors united to work an apparently racial effect; these factors are so intricately and reciprocally interrelated as to preclude definite isolation and tracing of the complete effects of any one. The patent results are thus more or less matters of environment as well as of differences in germ-plasm, of euthenics as well as eugenics. . . . A just weighing of all this evidence, however, leaves a decided balance in favor of grave racial hurt in consequence of war, and this certainty is cumulative, becoming more definite with the consideration of each new area. Each of the other baneful influences associated with the problem, social, cultural and economic devastation, emigration, pensions, etc., is nevertheless the direct consequence of war and should be debited to it. Moreover, even granting that the South and the country as a whole are, relative to ante-bellum days, no poorer racially in consequence of the war—an assumption no one can maintain in the face of the enormous waste of one million splendid souls—it is further certain that, could we have had the inspiring presence and wise counsel of these martyrs and their potential offspring, the country would now be immeasurably better off in a yet higher average of physical, mental and moral stamina. In brief, the theoretical argument for reversed selection seems beyond question. The actual facts concerning our Civil War and the events which followed yield no direct countervailing evidence. We must, therefore, decide that the war has seriously impoverished this country of its best human values."

[2] The words of a Confederate officer.

PHOTOGRAPHS OF LARGE TREES

Sycamore in Indiana is Biggest Recorded in Prize Contest of Association—California Oak Tops List Among Nut-Bearers—Many New Records Established and Much Valuable Data Put on File by Competitors

BARRING conifers, the largest tree which the American Genetic Association has been able to discover in the United States is a sycamore at Worthington, Ind., 42 feet, 3 inches in circumference.[1] This is the result of offers of two prizes of $100 each for photographs of large trees, made in the JOURNAL OF HEREDITY for October, 1914, by Mr. Charles Deering, of Chicago, and Mr. W. A. Wadsworth, of Geneseo, N. Y.

The offer terminated on July 1, 1915, and brought to the office of the association photographs of 337 trees in all parts of the United States. Most of them were accompanied by data as to surroundings and history, which make a distinct contribution to our knowledge of native trees. To go over all this data and get out all that it has of interest to science will be the work of some months; in this issue of the JOURNAL little more can be done than to announce the most evident results.

Photographs of the Indiana sycamore were sent in by Herman L. Hayden, Worthington; Herbert H. Sloane, Worthington; and Dr. William B. Clarke, Indianapolis. After considering both the excellence of the photographs and the fulness of the information submitted, it was decided to award the prize of $100, offered for the photograph of the largest non-nut-bearing tree to Dr. Clarke.

The second prize was offered for the largest nut-bearing tree, and went without doubt to Charles Libhart, of Stockton, Cal., who submitted the photograph shown in Fig. 8 of a valley oak 37 feet 6 inches in circumference, standing on the ranch of B. F. Gruver in Priest Valley, San Benito County, Cal.

It is impossible even to mention all the valuable records sent to the association. Many persons, entering into the spirit of the contest, sent photographs with the remark that they knew the trees they submitted were not prize winners, but wanted them put on record for the benefit of science. Others sent particularly large specimens of species that ordinarily reach only a small size, realizing that the prize would go to some larger species, but desiring to aid the association in getting a record of the maximum attained by all species. Thus excellent specimens of such trees as the persimmon, holly, sassafras, chinquapin, catalpa and white birch were submitted, and make highly valued additions to the available information on large trees in the United States.

To return to the Indiana sycamore (Fig. 7*a* and frontispiece) detailed measurements of circumference follow:

1 ft. above the ground	45 ft. 3 in.
5 ft. above the ground	42 ft. 3 in.
East branch	27 ft. 8 in.
West branch	23 ft. 2 in.

The height is said to have been reduced considerably in recent years by wind and lightning; it is now estimated at 150 feet, while the spread is about 100 feet. As far as is known, these are the largest authentic measurements of a sycamore now living.

The American sycamore (*Platanus occidentalis*) is more correctly called the plane tree; it is not related to the Biblical sycamore (*Ficus sycamorus*, a species of fig), mentioned particularly in connection with Zaccheus who, as the old Primer put it, "did climb a tree, his Lord to see." The American sycamore is also known in some parts of the

[1] Unless otherwise specified, all circumferences given in this article refer to a measurement made 5 feet from the ground. This was the stipulation in the contest, and is in accordance with the general practice of foresters and botanists.

THIS IS PROBABLY THE LARGEST SHADE TR

Residents of the "corn belt" have long boasted of the fertility of their river bottoms; the existence of s
The sycamore here shown stands near the bank of the White River, in a field belonging to Solomon
is at the right. The tree is subject to frequent inundation, when the White River overflows its ban
the tree. It is entirely possible that this periodical inundation, like that of the Nile, is partly respo
has attained unusual size; old settlers tell of a sycamore, long since gone, which measured 67 feet in
foresters declare that not to be the case; its unusual form is due to the fact that at an early age it b

NOW STANDING IN THE UNITED STATES

a specimen as this proves that the rich, black loam can produce to perfection bigger plants than maize.)ixson, of Worthington, who stands at the left; the competitor, Dr. William B. Clarke, of Indianapolis, nd deposits a new layer of silt on the fields; once, at least, the water has reached as high as the fork of le for the fertility of the region and the growth of the trees, more than one of which in that region ımference. It has often been suggested that this specimen is in reality two trees grown together, but :hed and grew up in two directions instead of one. (Fig. 7a.)

THE LARGEST NUT-BEARING TREE

California's valley oak (*Quercus lobata*) which grows in the hot interior valley and on the foothills of the Sierra Nevada Mountains is probably the largest nut-bearing tree in the United States, and this is by far the largest specimen which has come to the notice of the American Genetic Association. It stands on the ranch of B. F. Gruver in San Benito County, Cal., and was photographed on a vacation trip in August, 1910, by Charles Libhart of Stockton. Unfortunately, the photograph fails to convey a just idea of the size of this tree, which is surrounded by smaller oaks of the same species. It is 125 feet high and 37 feet 6 inches in circumference. According to Mr. Gruver, it bears a ton of acorns in a good season. (Fig. 8.)

country as the buttonwood or buttonball, in allusion to its large seed-balls, which hang on the tree all winter.

The tree here illustrated is located in the rich alluvial loam of the White River bottom. As this stream frequently overflows its banks, it periodically deposits a layer of silt around the tree; but the floods appear to have done no damage to it, although on one occasion it is said the water reached as high as the fork, 15 feet from the ground. It may be believed that this frequent deposit of alluvium is one of the factors which has caused the great growth of the tree. Many other large sycamores, beech and walnut trees have been produced in the same locality, but most of them have been long since felled for lumber. One of the sycamores which met this fate was so large that it could not be hauled to the mill, but was floated down the river; another, cut in the last few years within 500 yards of "the big tree," as the prize winner has been known in the region since the first settlers arrived, made five 10-foot logs, the largest of them 60 inches in diameter and measuring 1,960 board feet. The tap log was about 43 inches in diameter. These figures give some idea of the amount of lumber that a single one of these giants will yield.

As is most large sycamores, the base of this tree is hollow, the opening being on the opposite side from that shown in the photograph. Fire has recently damaged it.

That Indiana can produce even larger trees than this may be inferred from the following letter which appeared in the Indianapolis *News* of July 5, 1915, after a reference to the Worthington specimen:

LARGER ONE NOW GONE

"I can tell of a much larger one, but, unfortunately, the tree is gone, and nearly all who have seen it. I have twice written of it. The first time to the *Cincinnati Weekly Enquirer*, about the year 1867, the second time for the *Museum*, a monthly scientific journal, published at Albion, N. Y., by Professor Webb. I then made the claim that it was the largest tree ever grown in the United States this side of the Yosemite Valley. The article in question can be found in the December number, 1896, and embodies the following facts:

"The tree grew within a distance of 100 feet of the bank of Driftwood, on the east fork of White River, about 3 miles southeast of Brownstown, Jackson County, Indiana. My father bought the land on which it stood as school land, sixteenth section. I have often heard him tell about the tree. I never saw the tree standing, but the stump was still to be seen up to as late as 1864. I have on several occasions seen a pole 18 feet long turned completely around within the stump, which was hollow. It was measured by the surveyors of original survey, and was over 67 feet in circumference. The trunk of the tree was about 15 or 20 feet high when it made three branches. The smallest one of the three was more than 7½ feet in diameter, or, as father said, as high as a man's head when on horseback.

"This tree in part resembles the Worthington sycamore, in having branches near the ground. Of course, this tree was *P. occidentalis*.

"M. Crabb."

If Mr. Crabb's tree was measured at the ground line, 67 feet is not an impossible measurement, although it is doubtful if there is a tree of the species now living which reaches any such size. F. André Michaux, one of the earlier authorities on North American trees, and a naturalist whose accuracy is well attested, wrote[2] on the subject as follows:

"On a little island in the Ohio, 15 miles above the mouth of the Muskingum, my father measured a buttonwood which, at 5 feet from the ground,

[2] "The elder Michaux," under auspices of the French Government, explored North America from 1785 to 1796, studying the trees. His son, F. André Michaux, accompanied him in his later travels. The father published part of his work, but met with an untimely death in Madagascar; the son returned to America in 1801 and 1807 to complete the material for the "North American Sylva," which was published in Paris 1810-13. The quotation above and others in this article are from the translation published in Philadelphia, 1865, by J. J. Smith, with a supplement by Nuttall; Vol. II, pp. 50, 51.

CHESTNUT TREE FROM NORTH CAROLINA

After the California oak, the largest nut-bearing tree discovered by the association is this chestnut (*Castanea dentata*) 3 miles from Crestmont, N. C. It stands on the main range of the Big Smoky Mountains, dividing Tennessee and North Carolina; the altitude of the location where the tree grows is about 2,900 feet. This specimen is about 75 feet high; its girth at 7 feet from the ground is 33 feet 4 inches. Photograph from E. O. Abernethy, Crestmont, N. C. (Fig. 9.)

was 40 feet and 4 inches in circumference, and consequently more than 13 feet in diameter. Twenty years before, General Washington had measured the same tree, and found it to be of nearly the same size.

"In 1802 in a journey through the western States, I found on the right bank of the Ohio, 36 miles from Marietta, a buttonwood whose base was swollen in an extraordinary manner. My traveling companion and myself measured it, and at 4 feet from the ground we found it to be 47 feet in circumference. This tree, which still exhibited the appearance of vigorous vegetation, ramified at 20 feet from the ground. A buttonwood of equal size is mentioned as existing in Genesee. The astonishing dimensions of these trees recall the famous Plane Tree of Lycia, spoken of by Pliny, whose trunk, hollowed by time, afforded a retreat for the night to the Roman Consul Licinius Mutianius with eighteen persons of his retinue. The interior of this grotto was 75 feet in circumference, and the summit of the tree resembled a small forest."

THE BIGGEST ON RECORD

But the biggest record is that left by Robert Ridgway, who found the prostrate and largely decayed trunk of a sycamore near Mount Carmel, in Illinois, the crumbling base of which measured 66 feet in circumference.[3] At 20 feet from this, where the trunk divided into three large limbs, its circumference was apparently 62 feet. There is certainly no other broad-leaved tree on record in North America which equals these dimensions.

Mention was made, in the quotation from Michaux, of the oriental plane tree (*Platanus orientalis*), which has been introduced to America and is found in many parts of the United States. It may be interesting to digress long enough to see the size this historic tree reaches. Elwes and Henry,[4] who have made a particular study of the records of individual trees, write:

"One of the most remarkable was a tree growing in the village of Vostiza, on the Gulf of Lepanto, in Greece, which measured, in 1842, 37 feet 4 inches in girth at 5 feet from the ground, and was estimated to be 130 to 140 feet in height. This tree is supposed to be the one referred to by Pausanias, who wrote in the second century A. D., yet in 1842 the trunk appeared to be perfectly sound, though many of the larger branches have succumbed to age and storm.

"The famous plane of Bujukdere on the Bosporus is not a single trunk, but is formed of nine stems fused together. According to Ch. Martins, in September, 1856, the height was 200 feet—evidently an exaggeration—with a spread of branches 373 feet in circumference. One trunk girthed 18 feet; two trunks united together for some distance girthed 36 feet, the remaining six trunks being in an ellipse of 76 feet. One of the stems was hollow and afforded stable room for two horses.

"The tree of the Janissaries, the ancient plane which stands in the Court of the Janissaries in the Old Seraglio at Constantinople, was 39 feet in girth at 3 feet from the ground in 1890.

"In the *British Medical Journal* of June 21, 1902, there is an excellent account, with illustrations, of a plane tree in the island of Cos, which from its appearance must be one of the oldest trees in the Mediterranean, if not so old as its somewhat mythical history alleges. Local tradition says that under this tree Hippocrates, the celebrated Greek physician, taught the art of healing no less than 2,300 years ago. . . . Mr. Von Holbach, who measured it, gives the girth of its hollow trunk as 18 meters.

"Bonvalet, on his way from Samarcand to Amu, states that he halted at Sarifui, near the residence of the chief, under a plane tree, which was about 37 feet in diameter at 6 feet above the

[3] Proc. U. S. Nat. Museum, 1882, p. 288.

[4] H. J. Elwes and A. Henry, "The Trees of Great Britain and Ireland," Vol. III, p. 623; Edinburgh, 1908.

CONNECTICUT'S FAMOUS ELM AT WETHERSFIELD

"The Great Elm" has always been claimed by people in Connecticut to be the largest in the United States, and it seems quite likely that this claim is well founded. The American Genetic Association has not been able to get authentic record of any larger living specimen. The smallest diameter of the trunk (4 feet from ground) is 28 feet, while the basal girth, swelled by buttresses, is 55 feet 6 inches. Its height is approximately 100 feet. Estimated to be 250 years old, the tree seems to be in full vigor at the present time, and as the residents of the town have enough civic pride to care for it, the tree should live for several generations more. Photograph contributed by F. W. Tuttle, Hartford, Conn. (Fig. 10.)

ground. In his book, a picture of the tree is given, and a great limb comes off low down, which evidently was included in the above measurement. The tree appears to be about 50 feet in girth at the base below where the limb comes off. Another enormous tree, 49 feet in girth, stands in the grounds of the mosque of Tajrish, a village in the Elburz mountains, north of Teheran in Persia."

Although a number of other fine sycamores were sent to this association, none of them could compete with the Indiana specimen, and it seems extremely probable that this is the largest tree in the eastern United States at the present time. When one gets to the Pacific Coast, he enters the region of the Sequoias, whose giant bulk puts them in a class by themselves. Indeed, specimens of the Big Tree (*Sequoia*

gigantea) can be found which are almost as large in diameter as the Worthington sycamore is in circumference.

As was expected, all the nut-bearing trees proved to be considerably smaller than this sycamore. The California oak was easily first, but a close second was the big chestnut near Crestmont, N. C., sent in by E. O. Abernethy. At 7 feet from the ground this specimen measured 33 feet 4 inches in circumference, and owing to the peculiar formation of the trunk, it would have yielded much larger figures, if measured at a lower point. It is fair to assume that the chestnut represents the largest nut-bearing tree in the eastern United States, and is only surpassed by the huge oaks of the Pacific coast.

On this subject, Michaux wrote (III, p. 12): The chestnut "prefers the sides of the mountains or their immediate vicinity, where the soil in general is gravelly, though deep enough to sustain its perfect development. The Chestnut of the Old World attains its greatest expansion in similar situations: an example is said to exist on Mount Etna of a Chestnut 160 feet in circumference, or about 53 feet in diameter, and large enough to shelter 100 men on horseback beneath its branches; but its trunk is hollowed by time almost to its bark; near it stand several others more than 75 feet in circumference. At Sancerre, in the Department of the Cher, 120 miles from Paris, there is a chestnut which at 6 feet from the ground, is 30 feet in circumference; 600 years ago it was called the *Great Chestnut* and, although it is supposed to be more than 1,000 years old, its trunk is still perfectly sound and its branches annually laden with fruit. I have never met with instances of such extraordinary growth in the United States; but the American species is probably susceptible of an equal development, since in the forests of North Carolina, it is commonly as large and as tall as the corresponding species in those of Europe. I have measured several stocks which at 6 feet from the ground, were 15 or 16 feet in circumference, and which equalled the loftiest trees in stature."

Compared with this North Carolina specimen, the big chestnuts Michaux saw in the United States seem decidedly small. The one figured here (Fig. 9) appears to have been overlooked by all the botanists of the United States, none of whom mentions a specimen so large; but the figures in this case are given by professional lumbermen, who have had enough experience to know how trees are measured. In spite of Michaux's prediction, it appears that even at its maximum, the American species (*Castanea dentata*) does not attain such a large size as the European species (*Castanea sativa*); Elwes and Henry say (IV, p. 847) in regard to the English record:

"There is no doubt that the most celebrated, and perhaps the oldest planted tree in England, is the Tortworth chestnut. . . . Strutt says that in 1766 it measured 50 feet in circumference at 5 feet from the ground. . . . It was said by Sir R. Atkyns, in his 'History of Gloucestershire,' p. 413, to have been growing in King John's reign, and to have been '197 yards in compass.' At present it is by no means a beautiful tree, and so much of its original trunk is decayed that no measurement is of much value."

MAGNIFICENT ELMS

The elms of the eastern United States are among the largest shade trees, and the finest living specimen of this species (*Ulmus americana*) is probably the historic one at Wethersfield, Conn., reproduced in Fig. 10. Its history is described interestingly in a letter from Jared B. Standish, president of the Village Improvement Association. Wethersfield, it will be remembered, was settled in 1634, and is considered the first civil settlement in Connecticut. There seems to have been a wave of enthusiasm for civic beautification, twenty-five or fifty years after the founding, and it is believed that the Great Elm was planted at that time. In many of the pretty villages of the Connecticut River Valley, a row of elms through the middle of the entire village, with a road on each side, was established at that time.

WHAT IS LEFT OF A GIANT ELM

One of the purposes of the association's search for photographs of large trees was to arouse public interest in the subject and lead to the preservation of fine specimens. This photograph shows what is too often the fate of the most magnificent trees. It represents the remains of a swamp or white elm (*Ulmus americana*) near Morgantown, W. Va., measuring 33 feet in circumference. According to A. O. Woodfill of Morgantown, the photographer, the tree was deprived of its largest branches eight years ago, because many people sought shelter under the tree during storms, and the heavy "top hamper" was deemed unsafe. The trimming was apparently too severe, however, for the tree died, and is now nothing but a stump 50 feet high. It stands in black, sandy loam on the edge of a small swamp, surrounded by many small elms. (Fig. 11.)

In the early days of Wethersfield, open-air meetings were held under the Great Elm, and Charles Wesley delivered a sermon there in his tour through the Colonies in 1750.

In recent years the tree has been threatened, both by decay and by insects, but the Village Improvement Society has acted promptly in both cases, and the tree gives promise of ornamenting the village for many years to come. It is commonly believed by the inhabitants to be the largest elm in the country, and this appears to be correct. The association is in receipt of a photograph of a much larger elm of the same species from Morgantown, W. Va., but the latter specimen is now nothing more than a 50 foot stump, thanks to the indiscreet precaution taken eight years ago, of trimming it far more severely than it could endure.

Next to this, the finest elm reported is the "Rathbone Elm," a beautiful specimen located in Rathbone addition to Marietta, Ohio, which was photographed by H. P. Fischer of Marietta. It is 27 feet in circumference, 85 feet high, and in symmetry is quite the equal of the Connecticut specimen.

Both these specimens are larger than those which the literature cites. Elwes and Henry, for example, discussing the elm in New England, where it is particularly at home and particularly dear to the inhabitants, remark (VII, p. 1856):

"Though some of the historic trees mentioned by Emerson and other writers are now dead and decayed, there are still many splendid survivors of the original forest. Among these none is larger and more symmetrical than the Lancaster Elm in Massachusetts, which Professor Sargent showed me in May, 1904. It grows on deep sandy soil in the rich valley of the Nashua River, and measured 105 feet by 24 feet at 5 feet from the ground."

One of the interesting features of the contest has been the revelation of the number of trees in different localities which are locally reputed to be the biggest of the kind in the country. An elm at Somersworth, N. H., for instance, which is said to be considered by people in that section as the largest in the United States, proved to be only 14 feet 2 inches in circumference. By the side of such a specimen as the one lately killed at Morgantown, W. Va. (Fig. 11), this New Hampshire tree looks like a sapling, although in a grove of ordinary elms it would be most imposing in appearance.

THE SASSAFRAS RECORD

In many cases, the trees in which local pride expends itself are relatively insignificant specimens. An amusing instance of this is the sassafras, a tree which most people think of rather as a shrub, to be grubbed out of fields with much labor. Not long ago a town in Georgia made the modest announcement that it has the largest sassafras tree in the world—something over 7 feet in circumference. Jackson County, Ohio, immediately took up the challenge and ostentatiously produced a specimen of 7 feet in circumference at 3 feet from ground; whereupon Madison County, Ohio, jumped into the fray with a loud noise and a sassafras tree 9 feet 2 inches in circumference at that height, 8 feet 7 inches in girth at 5 feet from the ground.

This association has received from J. B. Corbin, of Juniata, Blair County, Pa., photographs of a beautiful sassafras 9 feet 7 inches in circumference at 7 feet from the ground; but all of these specimens are dwarfed by one at Horsham, Pa., 16 miles north of Philadelphia. This specimen was brought to light by W. H. Lamb, of the Forest Service, who secured photographs and description of it from Isaac Parry, of Horsham; its smallest girth, at 4 feet from the ground, is 15 feet 10 inches.

Some of these trees which are the particular objects of local pride have special points that are noteworthy, but do not bring them under the rules of this contest. Thus, many trees make up in height or spread what they lack in girth; but as girth is the only measurement which the ordinary person can take with accuracy, it seemed necessary to depend largely on this, in determining the merits of the trees submitted in this contest.

A LOUISIANA PECAN TREE

Although this is not the largest pecan tree in the country, it is perhaps surpassed by only one specimen, and its girth (19 feet 6 inches) is several inches above the maximum recorded by foresters. Its height is estimated at 150 feet. This pecan (*Hicoria pecan*) is located on the east bank of Cane River (Bermuda P. O.), Natchitoches Parish, La., and was photographed by Mayo S. Keator, East St. Louis, Ill. (Fig. 12.)

RECORD-BREAKING CATALPA

Many people think of *Catalpa speciosa* only as a quick-growing tree, planted in immense groves for the speedy production of fence posts and railroad ties. Michaux declared, "In these southern regions it frequently exceeds 50 feet in height, with a diameter from 18 to 24 inches." Later authorities allow it a maximum height of 120 feet and a maximum diameter of 4½ feet. Here is a specimen which, although only 75 feet high, has a girth of 16 feet. It is standing near Luxora, Ark., and was sent in by S. E. Simonson. (Fig. 13.)

This told against such trees as the famous Hooker Oak of Chico, Cal., photographs of which were submitted by half a dozen persons who will probably be quite surprised to learn that it is not the largest oak in North America. Its smallest circumference (3 feet above ground) is only 21 feet 8 inches. This is almost insignificant in comparison with the tree of the same species, illustrated in Fig. 8. The Hooker Oak, however, has a height of 105 feet and it is probably on this account that the famous English botanist, Sir Joseph Hooker, who measured it in 1872, pronounced it the largest oak in the world, as far as his encyclopedic knowledge extended. Dr. Charles Sprague Sargent of the Arnold Arboretum, Boston, who is perhaps the greatest authority on North American trees, is quoted as having said that he knows of no other tree in the United States which equals it in spread of branches. The outer circumference of the head is about 450 feet, and it has been calculated that, allowing 2 square feet of shade to each person, 7,885 people might find shelter from the sun under its branches.

Among smaller species of trees, one of the fine specimens sent in is the white birch (*Betula populifolia*) on Switzer Hill in the township of Athol, Worcester County, Mass., the smallest circumference of which is 12 feet 2 inches. This is considerably larger than the maximum ordinarily calculated for the white birch. The photograph was sent in by Philip R. Thayer, of Athol.

VIGOROUS HYBRIDS

As hybrid trees are notably rapid and vigorous growers, it is not surprising to find some of them in any list of big trees. Readers of the JOURNAL OF HEREDITY will remember the great James River Walnut described by Peter Bisset last year (Vol. V, p. 98). That supposed cross between the butternut (*Juglans cinerea*) and the Persian, improperly called English, walnut (*J. regia*) is 31 feet 3 inches in circumference at 4 feet from the ground, and is probably not much less than 200 years old. Some of the hybrid walnuts produced for commercial purposes in California during recent years have been reputed to be the fastest growing hard wood trees in the world, and notable among them is the Paradox Walnut, a cross between *J. regia*, the Persian (English) walnut, and a black walnut. One planted only about forty years ago at Yuba City, Cal., has now attained a circumference of 18 feet 7 inches at 4 feet from the ground, and a height of 100 feet. Photographs of it were submitted by H. H. Jacobs, of Santa Barbara, Cal. It is likely that this tree, which appears to be a natural, not an artificial, hybrid, is a cross between the Persian walnut and the black walnut of northern California, *Juglans californica*, var. *hindsi*.

It is perhaps worth noting that the name "Paradox" is the invention of the California plant breeder Luther Burbank, who applied it particularly to his own crosses. By common usage, however, it has now come to designate any cross between the Persian walnut and a black walnut, whether the latter be the California species (*J. californica*) or the common black walnut of the eastern forests, *J. nigra*. Such crosses are made very freely under natural conditions, and in nurseries sometimes take place to such an extent as to be really troublesome to the horticulturist. The California black walnuts also cross readily with the eastern black walnut, the resultant hybrid being designated, after Burbank, as "Royal."

A TREE FAVORED BY LUMBERMEN (See opposite page)

The yellow poplar or tulip tree (*Liriodendron tulipifera*) is a favorite with lumbermen in the Southern States, because of the large amount of timber which can be cut from its trunk. As shown above, its growth habit is such as to allow the production of the maximum number of board feet. This specimen, which is considerably larger than the limit for the species set in the manuals of forest trees, grows on Reems Creek, N. C., and was photographed by John R. Hess, of Providence, R. I. He gives the height as 198 feet and the circumference, 4 feet above the ground, as 34 feet 6 inches. It is indisputably one of the finest tulip poplars in the United States. (Fig. 14.)

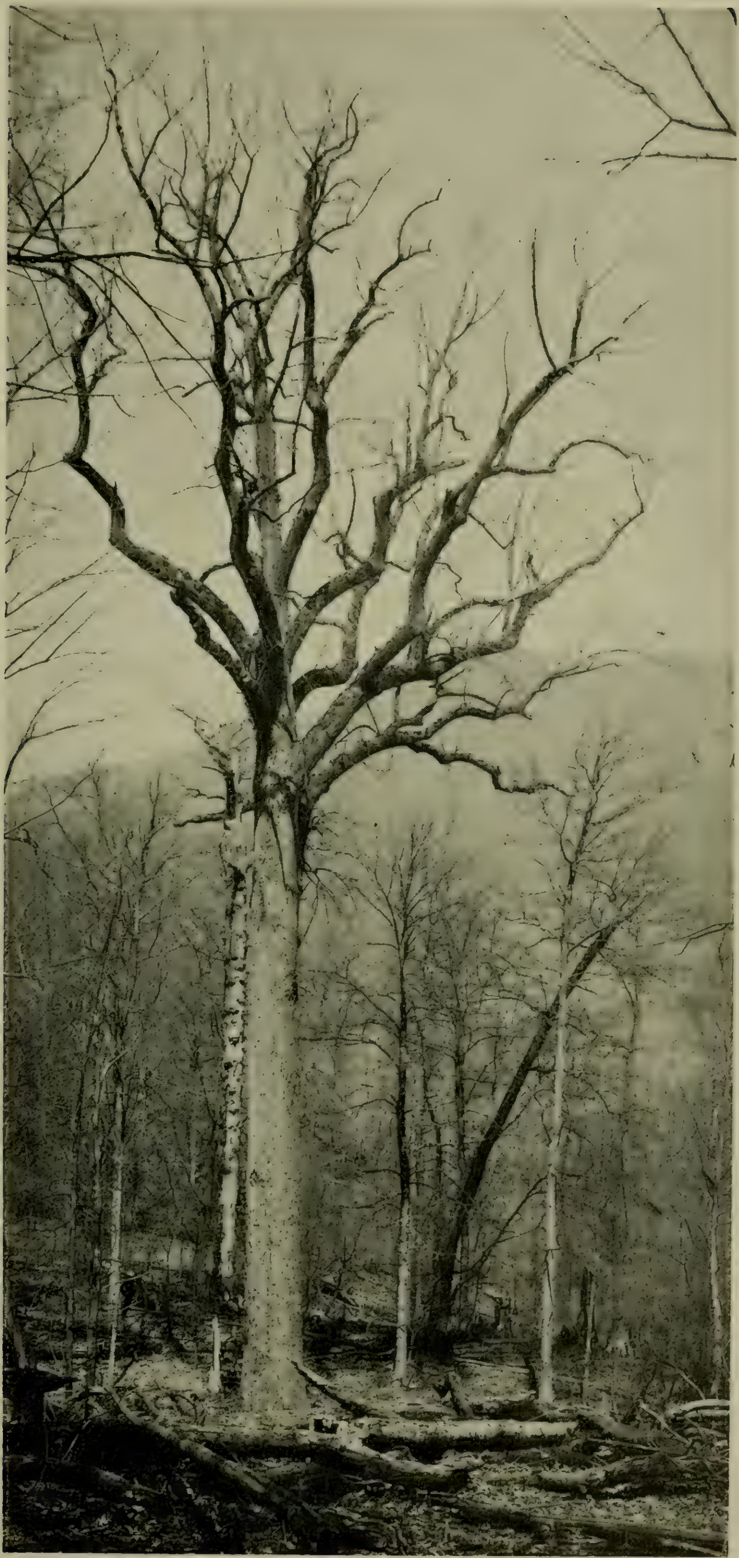

Fig. 14—Legend on opposite page.

Like many hybrids, these walnuts show a tendency to partial sterility, and are valuable for shade or timber rather than for nuts. In a few cases good nuts have been produced, but in general they are characterized by very light production, and the nuts are so hard-shelled and inferior as to have little commercial value.

Another magnificent nut tree, in its own species, is the pecan of Louisiana (Fig. 12), contributed by Mayo S. Keator, of East St. Louis. It stands near the east bank of a stream known as Cane River, Natchitoches Parish, La., and measures 19 feet 6 inches in circumference, with a spread of limbs of about 100 feet. It is far above the ordinary maximum of this species, and is exceeded, so far as this association has been able to learn, by only one specimen in the United States—an Oklahoma tree, which is credibly said to have a girth, breast high, of 23 feet. Some of these huge nut-bearing trees are decidedly valuable possessions: R. H. Kersey, of San Antonio, Texas, sends in the account of a pecan more than 5 feet in diameter, owned by Felix Heerman on the Medina River 13 miles from San Antonio, which produces as much as 2,000 pounds of nuts in a single season, and rarely fails to yield a good crop.

TALLEST TREE REPORTED

The magnificent yellow or tulip poplar of the Southern States (*Liriodendron tulipifera*), is, by reason of its habit of growth, so suitable for lumbering that it is difficult to save fine speimens. It is interesting, therefore, to know that the best one reported to this association (Fig. 14) is on private property where it is likely to be protected. This tree, contributed by John R. Hess, of Providence, R. I., stands in a "cove" near the bank of Reems Creek, not far from Craggy Mountain and about 17 miles from Asheville, N. C. It is stated to be 198 feet high and at 4 feet above ground has a circumference of 34 feet 6 inches. By the neighbors it is said to be the largest tree east of the Rocky Mountains, according to Mr. Hess. It may well be the largest tulip poplar, but cannot compete with some of the sycamores.

The soil where it stands is very rich, leaf mould being constantly washed down from the hillsides on its roots, as into a pocket, and this continuous fertilization may be partly responsible for the magnificent growth of the tree. It would be a matter of great difficulty, although of much interest and importance, to determine the relative share of heredity and environment in producing huge trees such as this contest has brought out. A long series of experiments might tell the story, and it would be well worth while for some one to get seeds from the best trees enumerated in this article, and grow them under a variety of conditions. Until this has been done, one can only proceed on the assumption, based on general considerations and experiments with smaller plants, that heredity is the fundamental factor but that proper environment is necessary to give heredity a chance to express itself.

Although the Michaux admired the tulip poplar, they seem to have seen no very fine specimens. André remarks[5] that his father found the best ones in Kentucky.

"He observed many of them in passing which appeared to be 15 or 16 feet in circumference and $3\frac{1}{2}$ miles from Louisville, he measured one which, at 5 feet from the ground, was 22 feet 6 inches in circumference, and whose elevation he judged to be from 120 to 140 feet: the correctness of this estimate I have since had the opportunity of proving. Of all the trees of North America, with deciduous leaves, the Tulip Tree, next to the Buttonwood, attains the amplest dimensions; while the perfect straightness and uniform diameter of its trunk for upwards of 40 feet, the more regular disposition of its branches, and the greater richness of its foliage, give it a decided superiority over the buttonwood, and entitle it to be considered as one of the most magnificent vegetables of the temperate zone."

Elwes and Henry mention some larger

[5] Op. cit., Vol. II, p. 36.

specimens, but like the recent American writers on trees, they appear to have heard of none as large as the one here illustrated. They say[6]:

"The largest trees of this species, however, have been recorded by Professor R. Ridgway from southern Indiana and Illinois, near Mount Carmel, Ill. . . . Though the largest trees recorded by him have now been cut, reliable measurements were taken of a tulip tree which reached the astonishing height of 190 feet, exceeding that of any non-coniferous tree recorded in the temperate regions of the northern hemisphere. Another tree cut '8 miles east of Vincennes, was 8 feet across the top of the stump, which was solid to the center; the last cut was 63 feet from the first, and the trunk made 80,000 shingles.' The soil here is an exceedingly rich, deep alluvium, and the climate in summer very hot and moist.

"It is stated in *Garden and Forest*, 1897, p. 458, that at the Nashville exhibition a log of this tree was shown by the Nashville, Chattanooga and St. Louis R. R. Co., which measured 42 feet long, 10 feet 4 inches in diameter at the butt and 7 feet at the smaller end, containing 1,260 cubic feet of timber, and about 600 years old."

It is evident that the specimen illustrated in Fig. 14 outranks anything that has hitherto been reported. According to Mr. Hess, it has never before been photographed, and its publication herewith appears to establish a new record for this important species.

[6] Op. cit., Vol. I, p. 68.

DATA FORMERLY INADEQUATE

It is evident from the above records that the data on large trees in the United States, heretofore in the hands of men of science, was wholly inadequate. This was the principal reason why the association undertook to collect photographs, and it is a satisfaction to think that its purpose has been so well carried out, and that, thanks to the cooperation of hundreds of papers in giving publicity to the offer, and to the activity of 300 photographers who enlisted, the amount of available information on the subject has been notably increased. Although the prize offer is now terminated, it is the hope of the association that the expenditure of energy in this direction will not stop, but that tree lovers will be stimulated to more activity, in searching out specimens that can surpass those here recorded; and that they will also be spurred to take whatever steps are necessary to ensure the preservation of these magnificent members of the vegetable kingdom, some of which are certain to succumb to time, disease or greed each year, unless public sentiment interferes and demands their preservation.

Experimental Plant Breeding in Nebraska

Work in plant genetics at the Nebraska Agricultural Experiment Station has been largely concerned with maize and beans. The results obtained throw particularly bright light on the inheritance of quantitative characters such as size, which are, obviously, much less easily studied than qualitative characters such as color and pattern. The researches with maize, confirming those with a great deal of other material, indicate that a large number of separate factors are concerned in the production of any apparently simple quantitative character. In the single character of width of a grain of corn, for instance, it was decided that "Missouri dent and Tom Thumb pop probably differed by not over five factors and Missouri dent and California pop by perhaps as many as six factors influencing breadth of seeds." When it is remembered that each of these factors behaves independently in transmission, it will easily be understood how the progeny of crosses shows "almost every possible degree of width, thus giving rise to the condition known as blended inheritance," as distinguished from segregation, where the breadth of seed which characterized one or other of the parents would appear in full.

VALUE OF THE CONTEST

Photographs Received by American Genetic Association Throw Light on Many Interesting Problems—Awakening of Public Interest in Large Trees Will Be of Great Benefit to Science

W. H. Lamb
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THE interest of the forester and dendrologist centers upon several features in the contest of size among forest trees. Whatever may be the interests of the investigators in other departments of biology we are inclined to direct our attention to the ascertainment of what species reach the greatest size and of the maximum dimensions attained by every species. It is also of importance to consider the geographical location of these individuals with respect to the natural range of the tree.

The location and identity of the largest hardwood tree in the United States is a matter of considerable scientific and popular interest. Among coniferous trees the first place in size has been accorded the giant redwood of California. The size and age of these trees have long been a subject of great interest and have offered many opportunities for the free play of the imagination in correlating different stages of the development of one of these mammoth plants to different periods of ancient, medieval and modern history. Among broad-leaf trees, however, no one species stands forth as the colossus. The oaks, the chestnut, the sycamore, the yellow poplar, and a number of other broad-leaf trees all reach magnificent proportions. It is rather difficult to compare these trees in size. This is not only true because of the necessity of comparing different species but also on account of the variation in form among individuals of a single species.

Every tree has a form which it assumes under normal conditions. In some trees, especially among conifers, this form, deeply impressed for innumerable generations, has become fixed and hereditary to the extent that even when grown in abnormal conditions, it will assume the typical form. Very often, however, the special type of growth is not retained in a modified environment. It is true, especially among broad-leaf trees, that an immediate response to the advantage of more space results in a broad-headed and lateral growth which is not characteristic of the tree in the original forest where in dense stands a long, clear trunk is developed, and where lateral branches are suppressed.

IN THE PRIMEVAL FOREST

In the original hardwood forest of eastern United States the yellow poplar (*Liriodendron tulipifera*) and the sycamore (*Platanus occidentalis*) probably reached the greatest proportions. The yellow poplar developed a clear trunk and had a more uniform habit of branching than the sycamore; exceeded it in height and from the lumberman's standpoint was most desirable, since it would saw out more lumber; but the sycamore, although more irregular in habit, held first place in size on account of the massiveness of the branches, the primary limbs of a very large sycamore fully equaling an average forest tree in bulk.

The Pacific coast forest is made principally of coniferous trees, with broad-leaf trees occurring as undergrowth or as scattered individuals, and conspicuous only in valleys. The forest of eastern United States, containing about half as many coniferous tree species, has over four times as many broad-leaf species as are found in the western forest. It would be expected, therefore, that competition in size

among hardwood trees would be confined to eastern United States. But the original forest condition no longer prevails here. Clear lands and cultivated fields have largely supplanted the original forest growth. The giant trees which still remain are not the product of this new condition, however, but are the survivors of the original forest. Through accident, neglect and occasionally through early recognition of their value, they now occupy a position which has only been made permanent by the destruction of the surrounding forest. Soil and moisture conditions may now be considerably modified and may even be unfavorable for the growth of that species, but, notwithstanding, these patriarchs, vigorous even in age, may not have begun to exhibit the slightest deterioration. Standing alone these survivors occupy sites not unlike those of the isolated specimens of oak which are found growing naturally in the valleys of California. The age of some of these western oaks may be over 300 years. The isolated eastern trees may not have been in this condition for so long a time. As isolation appears to favor diameter growth the oaks of California are at no disadvantage in the contest for size among the hardwood trees.

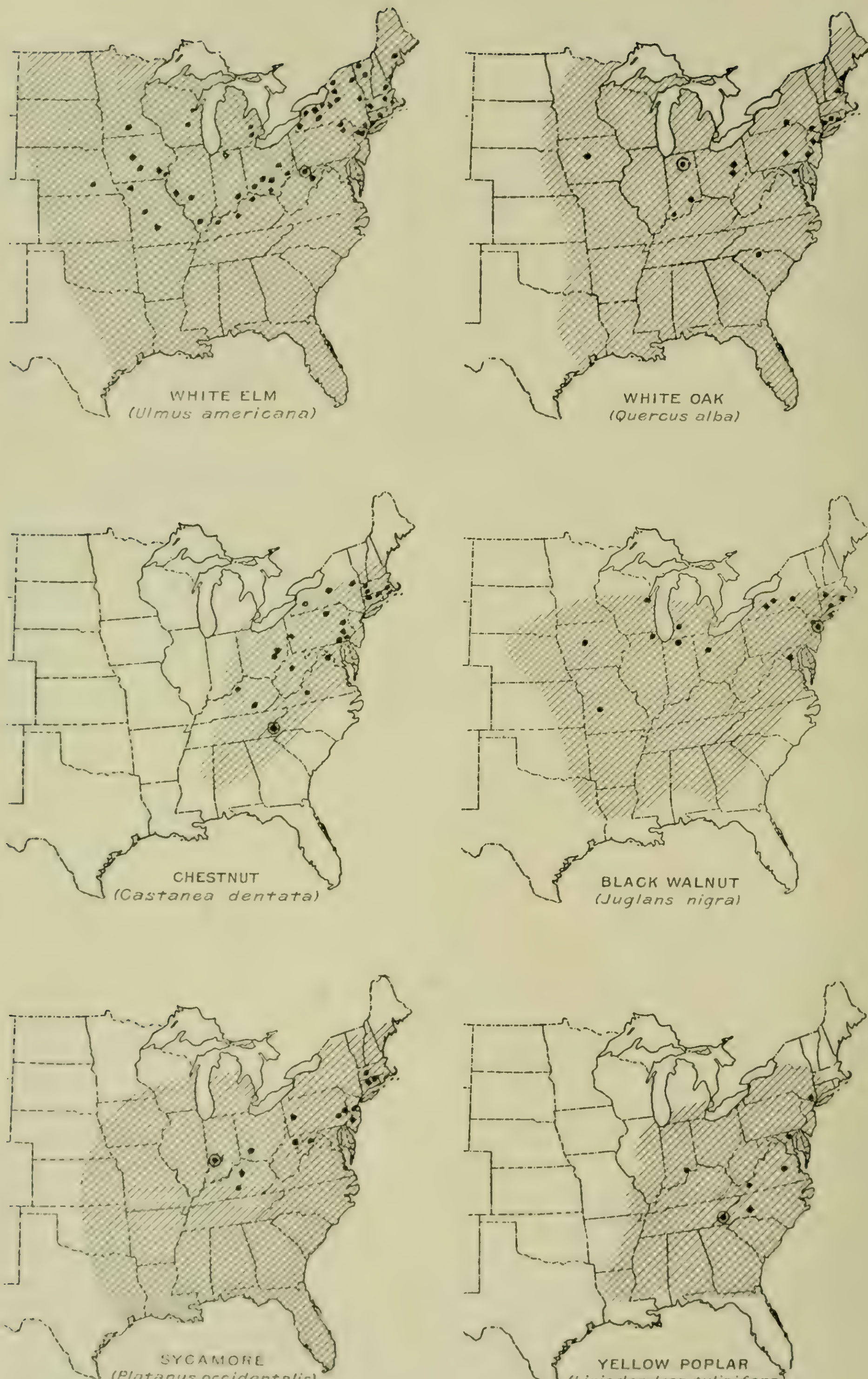
OLD AGE IN TREES

The largest individual of any tree species is generally taken by the forester as an index as to the maximum size attained by that species. In some instances fallen trees have been observed which have exceeded living specimens in size. Even in the present contest the largest specimen of elm submitted consists of only a dead trunk which, however, is still in an upright position. It is known that the life of this magnificent elm, having a circumference of 33 feet at 5 feet from the ground, was terminated by an outside factor, and that had it been protected, and if necessary assisted in the support of its massive branches, undoubtedly it would have grown on, reaching still greater proportions.

Exponents of the doctrine of indefinite longevity in trees maintain that they never die from old age or from causes analogous to those which determine the natural limit of animal life, but that they are destroyed by injury, disease, or other accidental influence. The theory is based upon the fact that a tree annually renews its growing parts. Each year the sapwood cylinder is increased on the outer side and on the inner side it is gradually being transformed into inactive heartwood. It is indeed evident that each species has an habitual period of death. The oak is notoriously long-lived. Willows and poplars have a brief existence. However, the early termination of the life of a tree may not be due to a natural death by old age, but to the fact that by the rapid growth, soft and fragile wood is produced which renders the species especially susceptible to decay or breakage. Moreover, it is likely that different species are susceptible to certain kinds of accidents. Plant disease, for example, favors some trees, and not others. A careful consideration of the causes of death in trees does not at all indicate that finally they must of necessity succumb to internal causes of destruction.

VALUE OF LARGE TREES

However, an appeal for the preservation of large trees is not based upon the scientific value which they may have in proving or disproving the doctrine of indefinite longevity. It would indeed be of greater value to such an investigation to experiment on woody plants of short life in order that results might be obtained within the period of observation of one investigator. The preservation of large trees yields scientific data of greater value in furnishing information as to the size attained by different species before they succumb to exterior or interior influences as the case may be. Unfortunately the same science which desires preservation of large trees also would dictate the felling of gigantic specimens in order to facilitate the inspection and study of the annual growth rings. Such arboricide would be most unfortunate. In the absence of superstition or peculiar beliefs which encourage the protection of vegetable matter we are apt to classify plants along with other natural objects. A



DISTRIBUTION OF THE LARGE TREES

Maps showing the range of six of the important timber trees represented in the contest, shaded. Dots represent location of the best specimens submitted, while dot surrounded by a circle indicates the point where the largest of them is situated. (Fig. 15.)

tree is a living thing. It enjoys freedom, suffers under confinement, reacts to poison, and according to late researches even exhibits phenomena in death not unlike that of the animal, although this is only evident by measurement with the most delicate and ingenious instruments. Trees live through many centuries and therefore become the oldest inhabitants of the earth. Their tremendous vitality, gigantic size and remarkable antiquity should inspire awe in the heart of the man who, with his feeble strength, small stature and short life does not hesitate to destroy the life of a patriarch which may have existed before the very dawn of botanical science. Only too often man is even willing to sacrifice a solitary monarch of the bygone forest in order to facilitate the cultivation of a field or to straighten a line of fence.

SENTIMENT ABOUT TREES

An appeal for the preservation of gigantic trees is not therefore made solely in the name of science. Preservation of these remarkable specimens will make possible valuable additions to our scientific knowledge, but the trees themselves in their beauty, utility and grandeur present an appeal not equalled by the interests of any scientific investigation. The possession of the largest individual of any species should be counted as a priceless treasure and should be cherished and protected beyond all other appurtenances of the estate on which it grows. These giants should be protected in every possible manner by their present owners whom they are destined to outlive, and legal provisions should be made to prevent their destruction by future owners of the land. A unique case is on record in Georgia where a tree was given legal possession of the ground upon which it grew. This tree is perhaps the only one in the world which holds a deed to itself and the surrounding ground. Nearly a century ago Col. W. H. Jackson, son of Governor Jackson and father of Chief Justice Jackson of the Georgia Supreme Court, placed the deed on record, in which he gave the tree entire possession of itself, together with 8 feet of ground on all sides.

This contest of the American Genetic Association confirms the fact that the sycamore is our largest hardwood tree. Data of scientific value are also presented in the case of many other species. Two introduced trees, Lombardy poplar and English walnut, are of special interest. The former was submitted from a region that was one time included in the treeless desert of the Middle West. Growing at Arapahoe, Neb., this European poplar has reached a circumference of 9 feet 10 inches and a height of about 100 feet within a period of thirty-two years. A specimen of white elm from Milford, Neb., reached a circumference of 10 feet, a height of 32 feet and a spread of 67 feet in about sixty-two years. An interesting competitor also is a specimen of hardy catalpa from Arkansas having a circumference of 20 feet at 3 feet from the ground and a height of 75 feet. A number of specimens exceeded the dimensions generally regarded as a maximum for that species.

PROBLEMS OF DISTRIBUTION

The student of forest geography will be interested in the location of the trees submitted with reference to the geographical distribution of the species. In the discussion of the scientific value of the prize contest it is not possible to go into great detail. However, it has been possible, even in the brief time available, to present maps of six species which have been selected on account of their importance as forest trees, as well as the large number of contestants among these species which are included. The location of the largest individual, whose size is given in the following table, is indicated by a small circle:

Common Name	Scientific Name	Location	Circumference
White elm	*Ulmus americana*	Morgantown, W. Va.	33 ft.
White oak	*Quercus alba*	Atwood, Ind.	21 ft.
Sycamore	*Platanus occidentalis*	Worthington, Ind.	42¼ ft.
Chestnut	*Castanea dentata*	Crestmont, N. C.	33¼ ft.
Black walnut	*Juglans nigra*	Hanover Neck, N. J.	24 ft.
Yellow poplar	*Liriodendron tulipifera*	Asheville, N. C.	34½ ft.

In the case of white oak the tree selected was merely identified by the contestant as "oak," but undoubtedly should be referred to *Quercus alba*. A white oak larger than this has been cut for lumber near Wilmington, Ohio. This tree measured 23 feet in circumference and was found to be 500 years of age.[1] Before drawing scientific conclusions from these data, account must be taken of the fact that the specimens are not necessarily the largest individuals of their kind, also it may be that the territory included by the different localities may be influenced by the channels through which the contest was brought to public notice. However, the absence of large trees from the western limit of the range of the species may be regarded as significant and, of course, should be viewed in the light of our knowledge of the fact that eastern hardwoods are migrating into the treeless prairie region. The occurrence of large specimens at the very limit of growth would tend to indicate either that the range was receding or else that there occurs at that place a sudden modification of conditions favorable to the growth of the species, or that the species is confronted by some physical or other barriers to its range extension.

The location of the largest elm in West Virginia is of interest. The New England States have long been regarded as producing the most remarkable examples of this species. It is not improbable that a specimen may be discovered which will restore the prestige of the New England elm. The location of the largest chestnut and yellow poplar in North Carolina is not unexpected, as some of the most magnificent stands of hardwood trees are found in the Southern Appalachians. The forests here are in virgin condition and this operates to the advantage of big trees in that they have been spared from the woodman's axe and to their disadvantage in that if left standing, unsurrounded by the crowding forest, they will attain greater lateral dimensions. The location of the large black walnut in New Jersey is of interest. The nearness of the eastern limit of its range, however, is not significant on account of the physical barrier of the Atlantic Ocean.

It must be understood that this article, to the preparation of which only a few hours could be given, can do no more than merely hint at the results of scientific value which will flow from the American Genetic Association's contest. In connection with the work of this office on the geographical distribution of trees many local problems will arise which can be more readily solved by reference to the photographs and letters which have been very kindly made available for reference through the courtesy of the association, than by any other way. The ultimate scientific value of these data, however, depends upon whether or not public interest in big trees ceases with the conclusion of this contest. As a basis for the actual determination of the largest individual among hardwood trees, and of the largest representative of every tree species, the data secured will prove of immense value. If readers will be good enough to continue to call the American Genetic Association's attention to the occurrence of notable trees, giving all available information on their history, condition and size, they will be rendering valuable assistance in our pursuance of these scientific investigations.

[1] An interesting account of this tree with data on its life history and the variation in the number of annual rings to the inch from the center to the outer surface is to be found in the National Coopers Journal, Philadelphia, July, 1909, pp. 1, 2.

Plant Breeding in South Carolina

Practical work is the rule at the South Carolina Agricultural Experiment Station, including breeding new varieties of cotton resistant to cotton wilt, breeding cotton for prolificness and a longer, stronger staple, breeding new types of rotundifolia grapes and apples.

ROSA HUGONIS

A New Hardy, Yellow Rose from China

David Fairchild

IF YOU see a particularly beautiful picture hanging in a friend's house your first question is, "Who painted it?", yet how few of the people who visit a rose garden and admire the beauties of color and form ever realize that practically all of our cultivated double roses are almost as much the result of man's work as a picture is. These living forms have arisen from the greatest artificial mixing of species which man has been able to bring about by the process of hybridization.

Wild roses from all over the world have entered into their ancestry and made them what they are, so that to a rosarian the history of a rose's ancestry is quite as fascinating as is a family tree to a student of genealogy.

To create a rose which will delight thousands of people must be as keen and wonderful a pleasure as intellectual man can enjoy; long after he has crumbled to dust generations of beautiful women, happy children, old men and young lovers will bury their faces in its petals and forget for the moment all else but its beauty.

Next to this pleasure, perhaps, is the enjoyment that comes from finding a wild rose in some far off land where it blooms unseen by cultivated eyes, and knowing that it will become the admired and loved garden treasure of a whole great civilized country.

I do not know if Father Hugo Scallan still lives or not, nor whether his life was a happy one, but if he is alive it would surely give him the keenest kind of pleasure to watch the career of a yellow rose which he found in China.

In 1899 he sent seeds of this rose to the British Museum, the authorities there sent it to the Royal Botanic Gardens at Kew—that great institution from which so many things of value have come into cultivation; and from Kew we obtained seeds for the United States. Very early each spring it blooms and it is yearly attracting the attention and arousing the enthusiasm of more and more flower-loving Americans.

Rosa hugonis is the name that has been given to this beautiful yellow rose that deserves a place in every dooryard in America. It is the earliest blooming of almost all the roses and earlier than any other yellow rose. It is of a lovely shade of yellow, is delicately perfumed and produces its single flowers in such profusion, as almost to conceal the plant. It is perfectly hardy, not being injured by —22° F., which cannot be said of most of the other yellow roses.

At the Arnold Aboretum near Boston Professor Sargent says it is perfectly hardy and free flowering and "is certainly one of the most valuable single roses which has lately been introduced into gardens." [1]

It seems entirely fitting that to Dr. W. H. Van Fleet, the originator of the Silver Moon and the Van Fleet roses, those masterpieces of rose hybridization, should be given the credit for insisting, as long ago as 1907, that *Rosa hugonis* be introduced into America for the dooryards of American homes and for the use of American rose hybridizers. It was his insistence that led the Department of Agriculture to import it from Kew Gardens.

In the photograph *Rosa hugonis* is shown as espaliered against the wall of the writer's house at North Chevy Chase, Md. Every spring, before anything but the Japanese flowering apricots (*Prunus mume*) and the single flowering Japanese cherries are in bloom, it has delighted all who have

[1] Arnold Aboretum, Harvard University Bulletin of Information, New Series, Vol. I, No. 5, p. 20.

ROSA HUGONIS, FATHER HUGO SCALLAN'S ROSE

This is not of so deep a shade of yellow as Harrison's yellow or the Persian yellow rose, but the bush seems to be perfectly hardy and it blooms with an abandon quite foreign to either of the others. Photograph of a bush espaliered against the house, In the Woods, North Chevy Chase. Photo by Crandall. (Fig. 16.)

A NEW YELLOW ROSE FOR THE PLANT BREEDER.

Rosa hugonis trained on a wall trellis at In The Woods, North Chevy Chase, Md. One of the earliest of all the roses and earlier than any other yellow rose. (Fig. 17.)

seen it, but even in winter it is ornamental because of its red-brown stems, red thorns and its picturesque growth.

When not trained against a wall it grows to a height of about 5 feet and its stems are clothed with numerous slender spines which are bright red on the straight young shoots. Its leaves are thin and delicate and so far as the writer's observations go it is not subject to the rose spot disease which turns briar rose bushes, such as Lord and Lady Penzance, into long unsightly masses of naked stems before the summer is over.

This lovely yellow rose has one small drawback. It does not seem to grow easily from cuttings or slips. It seeds freely, however, and can be raised in this way even should a quicker way not be discovered.

To those who are interested in roses it may be a matter of satisfaction to know, that the breeding of this rose with others is now going on here in America, and the appearance of some new descendant of Father Hugo Scallan's rose is probably merely a matter of time.

NEW PUBLICATIONS

THE MUTATION FACTOR IN EVOLUTION, with Particular Reference to Oenothera. R. Ruggles Gates, Ph. D., F. L. S. Pp. xiv+353, 114 figs., map and bibliography. London, Macmillan & Co., Ltd., 1915. Price 10*s*. net.

There is little left unsaid on the subject of Evening Primrose mutations, after Dr. Gates has finished with the subject. It has attracted an immense amount of attention in the last score of years—Dr. Gates' bibliography contains more than 450 entries—and the author has performed a real service by digesting the literature, to which his own contributions have been notable, and publishing it in this form. A considerable part of the book is, naturally, devoted to proving that there really is such a thing as a mutation. To those who have contended that the supposed mutations were merely the effects of hybridity, Dr. Gates answers that the cytological evidence disproves this; and the finding of a specimen of *Oenothera lamarckiana* which was collected by Michaux in America late in the eighteenth century shows that this chief of the mutating species is a real one, and not merely the hybrid product of some European garden. Dr. Gates discusses mutants in other plants, and animals, and concludes with a general theory of mutation, and a discussion of the significance of mutation in evolution.

SOCIETAL EVOLUTION, by Albert Galloway Keller. Pp. ix+338, price $1.50. New York, the Macmillan Co., 66 Fifth Avenue, 1915.

It is still a disputed point among sociologists, whether the mechanism of biological evolution—variation, heredity, selection, adaptation—is also the mechanism of the evolution of society. The distinguished professor of the science of society at Yale believes that it is, and has written this very readable, interesting and suggestive book to prove it, basing himself solidly on Darwinian foundations. As the evolution of society depends on changes in popular customs or mores, and the success of the eugenics program equally depends on a change in the mores, Professor Keller's extended and sympathetic discussion of eugenics must be of great interest to every geneticist. He points out that the maintenance mores, those which are principally economic in character, are much more easily changed than any others, and holds that the easiest route for eugenic propaganda is along this line. "Negative eugenics" is therefore most likely to be successfully put into practice, because it touches closely upon the struggle for a living. As to the immediate practicability of positive eugenics he does not show great enthusiasm, and it is likely that most eugenists will find their dreams a little less rosy, after reading his able review of the case.

The

Journal of Heredity

(Formerly the American Breeders' Magazine)

Vol. VI, No. 10 October, 1915

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The Journal of Heredity is published monthly by the American Genetic Association (formerly called the American Breeders' Association) for the benefit of its members. Canadian members who desire to receive it should send 25 cents a year, in addition to their regular membership dues of $2, because of additional postage on the magazine; foreign members pay 50 cents extra for the same reason. Subscription price to non-members, $2.00 a year, foreign postage extra; price of single copies, 25 cents.

Entered as second-class matter February 24, 1915, at the postoffice at Washington, D. C., under the act of August 24, 1912.

Date of issue of this number, September 27, 1915.

CALIFORNIA GROVE OF WASHINGTON NAVEL ORANGES

The orange industry in California represents one of the most highly perfected and organized horticultural industries in the world, and this grove near Riverside, California, gives a good idea of how the Washington Navel is grown in that state. (Frontispiece.)

WASHINGTON NAVEL ORANGE

Important California Citrus Fruit Originated in Brazil Nearly a Century Ago, Brought to United States in 1869—Comparison of Culture in California and Brazil—Importance of Bud Mutations[1]

A. D. Shamel

Physiologist, U. S. Department of Agriculture, Riverside, Cal.

THE Washington Navel Orange is one of the most interesting and important horticultural varieties in existence. The facts concerning its origin and introduction into the citrus districts of the United States and other countries are well established. The development of the culture of this variety on an extensive commercial basis has occurred well within the history of men now living. The recollections of these men concerning its early propagation, methods of planting and culture, are clear and well defined. While many of the men and women who were directly concerned in the introduction of this variety into the United States have passed away, they have, fortunately for posterity, left permanent records of some of their experiences in this connection.

The following paper is an attempt by the writer to bring together the available information concerning the origin and development of this variety. A study of the facts should be of intense interest to all plant breeders and others who are concerned in the development and improvement of our horticultural varieties. The historical data presented in this paper relating to the origin and development of the Washington Navel Orange in Brazil were collected by an expedition sent to that country by the U. S. Department of Agriculture in the fall of 1913, consisting of P. H. Dorsett, Wilson Popenoe, and the writer. The facts mentioned in the discussion of the introduction and development of the navel orange in the United States have been secured from papers and reports in the possession of the U. S. Department of Agriculture, and from first-hand interviews with some of the men and women in southern California who took part in this work.

ORIGIN

The Washington Navel orange originated at Bahia, Brazil, as a bud sport from the Portuguese variety of orange, *laranja selecta*, or the "select orange." This variety was undoubtedly introduced by the Portuguese into Brazil very soon after the colonization of that country. According to V. A. Argollo-Ferrão,[2] the navel orange appeared as a bud sport of the *laranja selecta* variety and was discovered and first propagated by a Portuguese gardener at Bahia in 1822. This account of the origin of the Bahian navel orange was confirmed by all other available information. The fathers or grandfathers of some of the orange growers at Bahia were personally acquainted with the circumstances connected with the origin and propagation of this variety and this knowledge was handed down to their sons and grandsons.

From the first, the seedless fruits of the navel orange trees were highly prized by the Bahians. The superior qualities of these fruits attracted general attention. The growers of the parent *laranja selecta* variety, recognizing the importance of the seedless navel fruits, planted that variety exclusively, as soon as trees were available for this purpose. At the present time the Bahian navel orange has practically supplanted all other varieties of oranges

[1] Read before the twelfth annual meeting of the American Genetic Association on August 3, 1915, at Berkeley, Cal.

[2] Inspectoria Agricola do 11° Districta, Bahia, Brazil.

grown in Bahia, with the exception of a sour or bitter variety, called *laranja de terra* (*Citrus vulgaris* Risso), which is grown for the production of seeds used for raising stocks. At Rio de Janeiro, commercial orchards of the *laranja selecta* variety are still cultivated by some of the farmers in agricultural districts near the capital. In the first orchard of this variety visited by the writer, a tree was found having a limb sport bearing typical navel orange fruits, while the remainder of the tree bore the regular seeded *laranja selecta* orange. Other similar cases were observed, tending to confirm the history of the origin of this variety as related by the Bahian orange growers and others. The navel orange variety in Brazil is called *laranja selecta de umbigo*, or the "select orange with the navel." This name in itself tends to confirm the established history of the origin of this variety.

NAVEL ORANGES IN BRAZIL

The Brazilian expedition found that the principal navel orange district in Brazil is that of Bahia. A few trees of this variety were found growing in the orange groves near Rio de Janeiro. We were informed on good authority that limited plantings have been made in some interior districts of Brazil, but in no case has the development of the industry reached such extent or importance as in the Bahian district. We found growing at Bahia about 50,000 bearing navel orange trees and about an equal number of trees which had not as yet reached the bearing age. A typical tree is shown in Fig. 1. Inasmuch as the trees are usually planted at the rate of about 100 per acre, there were about 1,000 acres of bearing and non-bearing navel orange trees in the Bahian district.

The development of this industry has been encouraged by the Brazilian Government, and particularly by the city of Bahia. We were told that within this municipality there are about 35,000 acres of land suitable for planting oranges. The city has established an experimental farm for the purpose of investigating methods of propagation, culture, and handling oranges for the benefit of citrus growers. Liberal inducements are given to prospective planters in the way of long time, low rentals and facilities for transporting and selling the crops. A strong effort is being made by the municipality of Bahia to encourage an export trade, particularly to the larger cities of South America, so that the existing demand for this fruit can be supplied.

Under present conditions the culture of the navel orange at Bahia is a profitable undertaking for the growers, the fruits retailing in the city of Bahia for an average of about 3 cents each. A typical Bahian navel orange is shown in Fig. 2. The expense of clearing the land, planting the orchards, and bringing them into bearing is frequently made up by the profits from the culture of mandioca[3] between the rows of orange trees. The bearing orchards are cultivated by scraping off the weeds from one to three times a year with a heavy hoe, or "enchada." About the only fertilizer used is barnyard manure. All of the growers of the larger orchards maintain dairies in connection with their farms, mainly for the purpose of securing manure for use in their orange groves. This manure is carefully conserved and is usually applied by burying it in heaps between the trees; on hillsides it is buried some distance above the trees, usually under the drip of the branches. It was the unanimous testimony of Bahian orange growers that mottle leaf and chlorosis of citrus trees could be cured by the liberal use of manure. Insect enemies and fungus diseases are not controlled artificially except in the case of ants. The ant colonies in the orchards are destroyed by digging them out or more recently by fumigation.

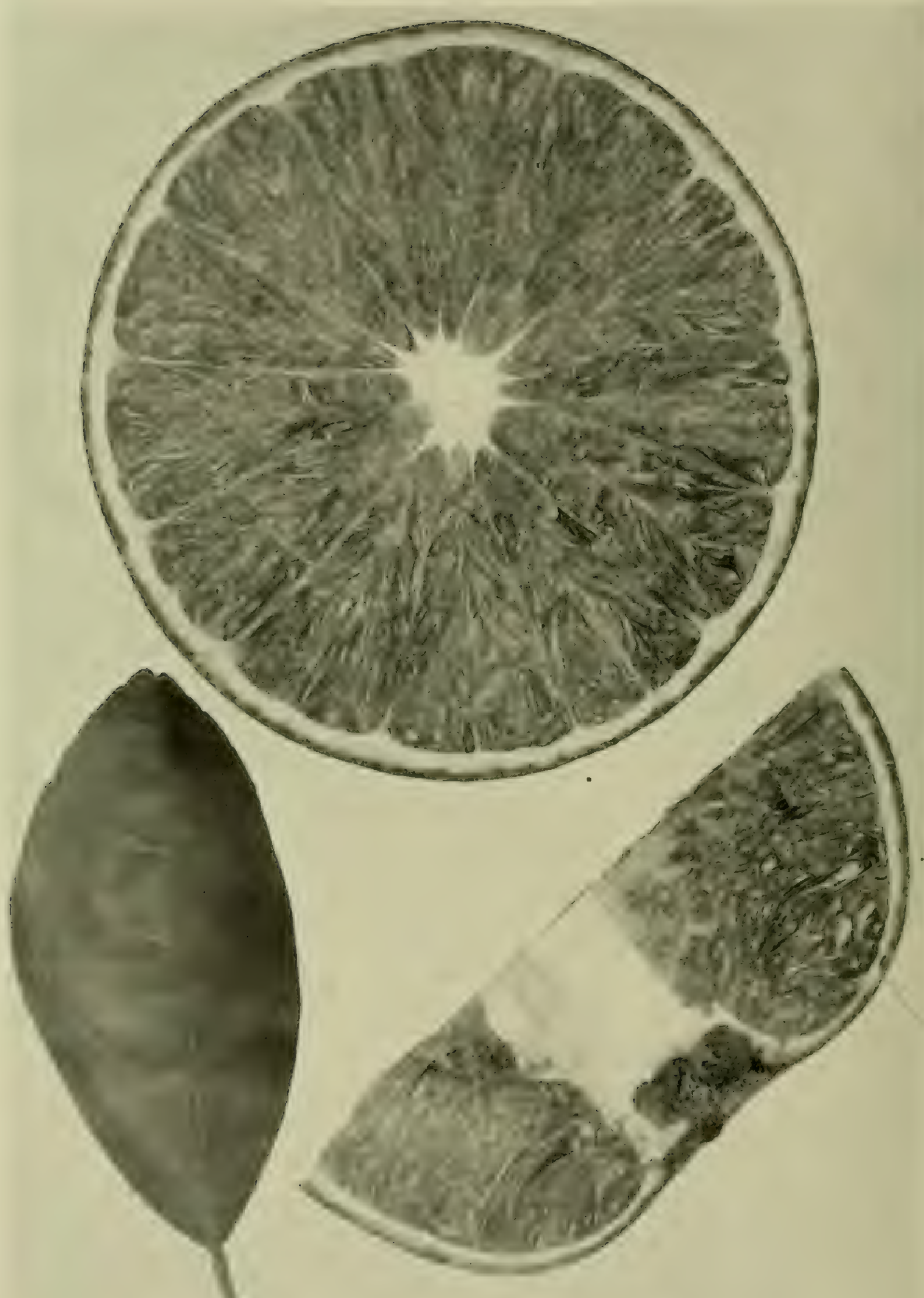
[3] Mandioca is the Brazilian name for the manioc or cassava (*Manihot utilissima* Pohl., Euphorbiaceae), one of the important food plants which is native of South America. It is widely cultivated for its roots, which sometimes weigh as much as 30 pounds and are 3 feet long. They are ground up, and the bitter, poisonous juice which they contain is expelled by drying on heated plates; the resulting product is known to almost every one in the United States under the name of tapioca.

NAVEL ORANGE TREE AT HOME

Typical specimen in the grove of Col. Frederico da Costa, Matatu, Bahia, Brazil. The navel orange of California was brought from Bahia, where it is believed to have originated as a bud sport about 1826. (Fig. 1.)

The oranges are usually picked by men climbing the trees, breaking off the spurs to which the fruits are attached, and dropping them to the ground. They are then collected into heaps; assorted into two grades, one consisting of the large, and the other of the small, fruits. The fruits are then loaded into boxes or packs and carried on horse or mule-back to the markets; or in some cases the buyers come to the orchards from the city and carry baskets of the fruits on their heads to the city. The steamships that call at Bahia take a considerable portion of the crop for use on their tables. A small quantity of navel oranges is now exported to Rio de Janeiro, Buenos Aires, and other South American cities, but not enough, we were informed, to supply the demand in those cities for this variety.

The navel orange orchards at Bahia are located on the higher lands and are given no irrigation—the annual rainfall at Bahia is about 50 inches a year, so that under normal conditions irrigation is not needed. We were told that in dry seasons the crops were comparatively light, while the best crops are produced during the wet seasons. The principal crop ripens in May, June and July, a period corresponding to our winter or the California rainy season. Another crop ripens in December, January and February, while on some of the trees ripe fruits are found the entire year. Our observations in this connection led us to the conclusion that



NAVEL ORANGE OF BAHIA

This fruit is a good sample of the navel orange as it still grows at the place of its origin. The skin is relatively thin and the navel rudimentary. Its quality is very good, although investigators differ on the question of whether the navel orange at Bahia is a fruit superior to the navel orange of California. (Fig. 2.)

this habit of fruiting was characteristic of certain types of the navel orange, one type having the habit of ripening its fruit in the winter, another type bearing ripe fruits in the summer, while a third type bears ripe fruits throughout the year, similar to the habit of the Eureka variety of lemon in California.

INTRODUCTION TO UNITED STATES

The Bahian navel orange was introduced into the United States through the efforts of the late William Saunders, Horticulturist and Landscape Gardener for that division of the Patent Office corresponding to the present United States Department of Agriculture. In his reports on this project, he mentions the fact that he learned from a woman correspondent of the existence of a seedless variety of orange at Bahia, about 1868. Through correspondence with the American consul at Bahia, Mr. Saunders secured a shipment of the seedless orange trees, but during the long voyage from Bahia to New York the trees died. Mr. Saunders again wrote the American consul and asked for another shipment of these trees, giving minute directions for the packing of them and their care in transit. Preparatory to the arrival of this second shipment, Mr. Saunders secured some seed from oranges in the Washington market and grew seedlings in the Government greenhouses. When the second shipment of trees arrived, they were in poor condition, but some buds were found to be alive: these were transferred to the seedlings in the greenhouse and a number of orange trees were successfully grown in this manner.

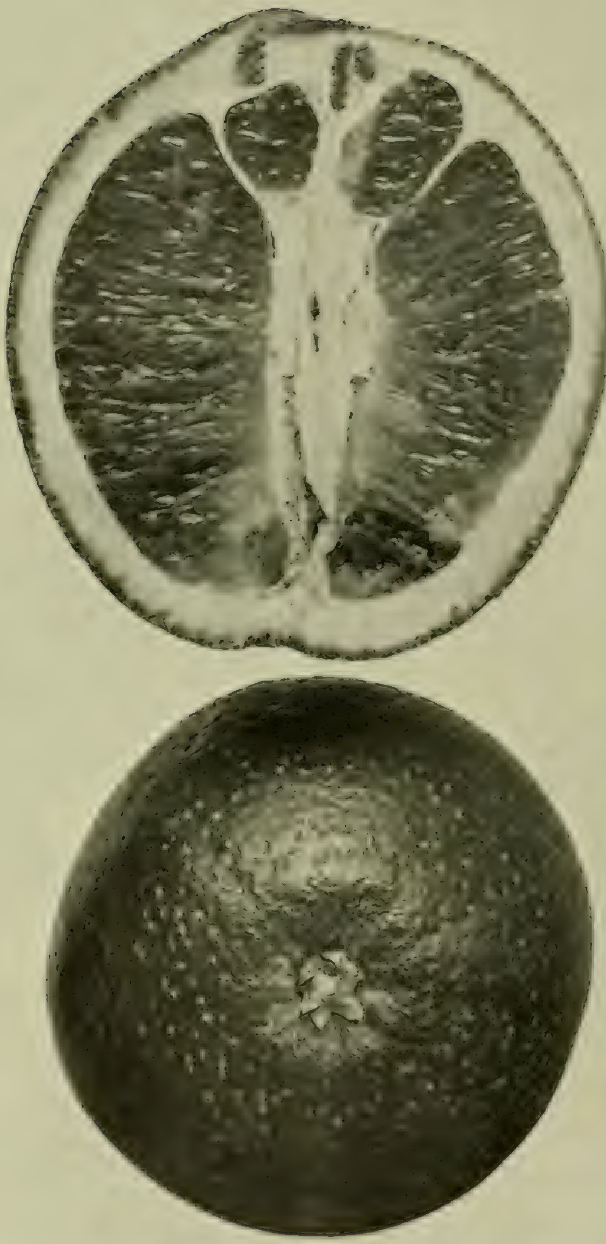
A former neighbor of Mr. Saunders in Washington, residing in Riverside, Cal., Mrs. L. C. Tibbetts, learning of the success of this introduction, wrote to Mr. Saunders asking for some of the trees. When the trees were ready for distribution in 1873, two were sent to Mrs. Tibbetts and most of the remainder to Florida, which was thought to possess more nearly ideal conditions for the growth of this variety. The two trees received by Mrs. Tibbetts were planted in her dooryard and were carefully tended by her personally until they came into fruiting. When the first fruits ripened on these trees, Mrs. Tibbetts invited her neighbors to assist her in testing them. These neighbors and Mrs. Tibbetts decided that this orange was superior in many respects to any then grown in Southern California and made every preparation to propagate this variety as rapidly as possible. Further experience confirmed the judgment of these pioneers, and as a result, the navel orange soon achieved a wide reputation on account of its superior quality, seedlessness, and other valuable characteristics. The trees sent to Florida proved to be somewhat unsatisfactory, particularly on account of low production in comparison with other varieties then grown there. While a small acreage of navel oranges is cultivated in Florida, this variety has never achieved any great commercial success or importance in that State.

ORIGIN OF THE NAME

Mr. Saunders distributed the navel orange trees under the name of the Bahian Navel orange, marking the origin of this variety in Bahia. The first important commercial orchards planted in California were grown near Riverside, and for a time the variety was known locally as the Riverside Navel orange. Later the successful introduction of this variety into other districts in California led to a general discussion of an appropriate name for the variety and at a public meeting called for this purpose, the growers united upon the name of the Washington Navel orange for the variety. This name was adopted in recognition of the fact that the variety was introduced and the first trees in this country were propagated by the Agricultural Department at Washington, D. C.

DEVELOPMENT OF THE INDUSTRY

The general introduction and development of the navel orange industry in California has occurred within the last forty years. From the two original trees planted by Mrs. Tibbetts in 1873, which are still living and producing fruits at Riverside, the industry has grown in California until at the present



NAVEL ORANGE OF CALIFORNIA

The skin of the California product is thicker than that of the Bahia fruit, the navel is much more highly developed, and the fruit has also a much higher and warmer color, externally, than does the orange of Bahia. Some of the changes that have taken place in it, during the forty years since it was introduced, may be ascribed to differences in climate and soil; others are imputed to further bud mutations. (Fig. 3).

time there are about 100,000 acres of this variety cultivated in the State. A typical Washington navel orange is shown in Fig. 3; a typical productive form Washington navel tree is shown in Fig. 4; and a typical Washington navel orange grove near Riverside, Cal., is shown in the frontispiece. The crop of navel oranges is about 25,000 carloads of fruit each year, containing about 10,000,000 boxes of oranges. From California, trees of this variety have been sent to Japan, Australia, South Africa, and other foreign citrus districts. In those regions the variety has become commercially important and its culture is being rapidly extended, so that it is becoming one of the leading citrus varieties of the world. The Washington navel orange in California has been the foundation upon which the citrus industry as a whole has been developed.

METHODS OF PROPAGATION

The methods of propagation of the Washington navel orange in California are similar in many respects to those practiced at Bahia. In California the variety is usually budded upon stocks from the Mission Sweet Seedling orange. In some districts it has been propagated upon stocks grown from grapefruit, the Florida sour orange, and the Florida rough lemon seeds.

TYPES FROM BUD MUTATIONS

In 1909 the writer began a series of observations on the behavior of this variety under different soil and climatic conditions in California. In the study of these trees, it was found that numerous diverse types of trees and fruits existed. Some of the striking types of trees were distinguished by their habits of growth, density of foliage, and other easily discernible characteristics. A close study of some of the trees disclosed the fact that they bore characteristic fruits. The variation in these types of the Washington navel orange, both as regards trees and fruits, was so marked that it was thought for a time to be due to a mixture of varieties. Later it was discovered that frequently trees grown from a single navel orange bud produced several characteristic types of fruits. In some cases this variation was found to occur as limb sports, in which case both the fruits and foliage on these sporting limbs were characteristic of the types to which they belong. In other cases these variations were found as single fruits.

IMPORTANCE OF TYPES

Systematic investigation of this subject was begun about this time for the purpose of discovering the extent and importance of the diversity of types arising from bud mutations. Plots of about 100 trees each were selected in representative orchards and careful performance records secured from each tree in these plots. After six years' systematic study, conclusions can be safely drawn as to the significance of bud mutations and the importance of the types of the navel orange originating from these mutations. It has been proven that the diverse types of the navel orange existing in the California orchards have originated from bud sports. The trees of these types have characteristic habits of growth and the fruits borne by these trees are of very widely differing commercial value.

FREQUENCY OF BUD MUTATIONS

The occurrence of these diverse types is very much more frequent than has heretofore been supposed to be the case. They are of great and vital importance to the growers from a commercial standpoint. One of the characteristics of some of the unproductive and undesirable types of trees is unusual vigor of growth. Frequently these trees stand out in orchards several feet in height above the neighboring trees and have a spread several feet in excess of that of the standard tree. These inferior trees also frequently produce an unusual number of so-called suckers, or very vigorous vegetative growth, which has heretofore been highly prized for propagation. As a result of this condition, there is little doubt but that in the successive propagations of the past years, an increasingly large proportion

CALIFORNIA NAVEL ORANGE TREE

The culture of the crop in southern California is in most respects very markedly different from that in Brazil. The trees usually get better care, more fertilizer and abundant irrigation, and therefore are likely to produce a larger yield than those in Brazil. (Fig. 4.)

of the trees have been propagated from the more vigorous growing, and as a matter of fact, least desirable type of trees for fruit production, both as regards quantity and commercial quality of the crop. In other words, there has been a steady deterioration in the characteristics of production of the variety from the propagation of these inferior and undesirable fruiting types.

Performance records of typical trees of the eleven common types of the Washington navel orange under comparative conditions for six years have established fairly well the behavior and the value of the trees of these types. The undesirable types, without exception, have been successfully top-worked, using budwood from select trees of the best types. The select

"AUSTRALIAN" NAVEL ORANGE

This peculiar form of the Bahia Navel seems to be the product of a bud sport or mutation similar to the one that produced the original seedless navel. The branch here shown is from a standard Bahia Navel orange tree in the grove of Col. Frederico da Costa, Matatu, Bahia, Brazil; similar specimens can be found in almost any part of the world where the variety is grown. On the whole, this "Australian" mutation is inferior to the standard type which produces it, and wise growers therefore do not propagate from buds of limbs bearing this sort of fruit. (Fig. 5.)

trees of the best types have also been topworked with budwood from the undesirable types, successfully demonstrating without any possibility of doubt that it is possible to transfer type characteristics from one tree to another by the use of buds selected on the basis of performance records. Propagations have been made from all of the common budsports and these propagations have been so successful as to prove the fact of the origin and development of these diverse types from bud mutations.

At the present time there are extensive commercial individual tree performance records being kept by navel orange growers in California for the purpose of locating the drone trees of the undesirable types. These inferior trees are being rapidly topworked, using budwood from trees selected on the basis of performance records. Some of the leading nurserymen have adopted the principle of propagation from select trees, propagating only from those trees producing large, regular, and valuable crops of the standard or best type of fruit as shown by actual performance records. It has been commercially demonstrated in this way that a valuable type of the navel orange can be isolated through bud selection based on performance records.

It is also believed as a result of the

evidence accumulated in the course of these observations, that the variation in this type can be controlled by bud selection, so that by this means the variety can be conserved, maintained, and improved.

In the consideration of the practical problem of maintaining the navel orange variety by bud selection, it has been found necessary not only to select trees from definite individual tree performance records, but also to make limb selections as well. This is done by cutting the budwood from the select trees with the ripe fruits attached and using only budwood from the limbs which produce the typical or standard Washington navel orange fruits. This budwood is of the preceding year's growth and while it is of small size, has been successfully used commercially. The buds from this source have been found to produce equally good if not better trees than those propagated from the larger and more rapidly growing wood.

TREE RENEWAL

Of the observations made in the navel and other orange districts of Brazil, one of the most interesting to the writer was the method of tree renewal practiced by the orange growers. We found existing a general belief that after fifteen or twenty years orange trees became unproductive and unprofitable. In such cases the tree tops are cut off and new tops grown from the old trunks. In the case of badly diseased and dying trees, they are cut back severely, sometimes to a point just above the bud union. Where the trees were in fair condition of vitality but decadent, only the smaller limbs are cut off, leaving the main limbs as a framework for the growth of a new top. The amount of tree top cut off is governed by the condition of the trees. The renewed trees were found to be surprisingly healthy, vigorous-growing, and productive. Many of the orange growers claimed that the fruits borne by these renewed trees were of better quality than those borne by original trees.

In consequence of this practice of tree renewal, no very old navel orange trees were found; the oldest was said to be about 40 years of age. However, in some cases, evidence was discovered where such trees had been renewed as many as four times, indicating that the trunks were from 60 to 80 years of age.

The method of tree renewal practiced by the Brazilian navel orange growers is chiefly of interest in that it tends to confirm the soundness of the principle of pruning based on the systematic renewal of the fruit-bearing wood in citrus trees.

BUDDING

Another interesting practice observed in the Bahian navel orange districts was the budding of stocks set in permanent orchard places. While the general method of propagation followed in the past at Bahia has been that of the ordinary nursery, the majority of the newer orchards were found to be propagated by budding the stocks in place. Certain advantages for this method of propagation are claimed by the Brazilian orange growers: *e.g.*, a more rapid growth of the budded tree, earlier fruiting, and greater resistance to diseases, as compared with the ordinary transplanted nursery trees. The stocks are budded higher than is the usual practice in this country—15 or 20 inches above the ground, and are usually about two years old when budded. The budding is done at all times of the year, but is said to be most successful during November, December, and January, the spring and summer seasons in Bahia. A shield bud is used as a rule, the budsticks being about the same size as the stocks to be budded.

BUD VARIATIONS

Bud variations were found in the Bahian navel orange, but apparently are not so frequent as in the California Washington navel orange trees. Distinct types of trees, as shown by habit of growth and other characteristics, were observed in all the orchards examined. On individual branches, leaf variations were very frequent. For instance, the variation of the petiole was particularly noticeable. The petiole

of neighboring leaves varied from broadly winged to wingless, winged on one side and wingless on the opposite side, very small to very large, and from one to three sets of wings. On one of the standard type Bahian navel trees, a sporting branch was found bearing typical flattened and wrinkled so-called Australian navel fruits, as shown in Fig. 5. One entire orchard of several thousand trees was observed planted to the Australian type of navel orange.

In one orchard we found well-established instances of reversions of the navel to the selecta variety of orange. In this orchard the owner, Col. Luiz de Suze Demetrio, one of the leading navel orange propagators of Bahia, told us that three typical fruiting *laranja selecta* trees in his orchard were grown from buds cut from a navel orange tree and propagated on sour orange stocks by himself.

Variability in time of ripening fruits, size, shape, navel characters, color, thickness of rind, amount of juice, character of rag, quality, and other characters, were particularly marked. To the writer, the most interesting observation in this connection was the variation in time of ripening the fruits, indicating the possibility of controlling this character in some measure through bud selection.

Most of the types of navel oranges found in California were observed in the orchards at Bahia.

It may be of some interest to note that the writer has found several of these typical budsports in the fruits produced by the two parent Washington navel trees at Riverside.

In a consideration of the factors involved in the successful development of the navel orange industry in California, the work of the pioneer orange planters must not be overlooked. These men and women settled in a desert. All of the problems incidental to bringing under cultivation this arid land were met with sublime courage, intelligence, and resourcefulness. Most of the settlers were fresh from plentifully watered, fertile lands and established conditions of eastern agricultural sections. The taming of the sagebrush lands, the development of water for irrigation, the discovery of new methods of culture to meet new conditions, needed iron determination and strong faith. How well these pioneers succeeded is shown by the wonderful orchards, perhaps the most perfect of all time, the beautiful homes nestling in the orange groves, and the highly cultured people who are enjoying the results of the efforts of the pioneers. It has been said that the man who causes two blades of grass to grow where one grew before is a public benefactor. What can we say of these pioneer orange growers who caused beautiful and useful orchards to grow where nothing grew before?

Berkeley Meeting of A. G. A.

More then 300 persons attended various sessions of the twelfth annual meeting of the American Genetic Association at Berkeley, Cal., August 2–6.

Two general sessions were held, while those interested in plant breeding met in three sessions and eugenics had one session. The program of every session was crowded.

As many of the papers as possible will be printed in the Journal of Heredity; the rest will appear in various other publications to which they seem most adapted.

It was decided to continue meeting in connection with the American Association for the Advancement of Science.

A Committee on Nomenclature was appointed by the presiding officer, Dr. E. B. Babcock, consisting of Herbert J. Webber, Chairman; R. Ruggles Gates, George H. Shull, W. E. Castle, Raymond Pearl, H. S. Jennings and Paul Popenoe.

NEW LIGHT ON EUGENICS

Psychologists' Study of Unconscious Phenomena Convinces Them That Many Traits of Adult Are Due to Impressions on Early Life, and Not to Heredity—Weakness of Some Eugenic Research[1]

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THE purpose of this brief paper is not to present a new, fantastic theory, but rather to sound a reasonable note of warning to some of our over-confident friends who are advocating a eugenic program based on slippery and insecure foundations. In this age of hyper-enthusiasm some of our fellow-workers are inclined to permit their theories and ideals to loosen their hold on the facts. Both eugenists and psychologists must be extremely careful not to forget that in both fields we are still dealing with "elementa." The amount of data which can be made of practical service is in some fields very meager. We must not permit our hopes to run riot with our facts.

The recent developments of genetic science have again brought to the fore, after a more or less prolonged period of exile, the view of the inheritance of acquired characters. This rejuvenation is receiving a great deal of acceleration, especially among psychologists, by the wider and wider acceptance of Semon's mnemic theory. The followers of Semon claim that ontogeny is a mnemic phenomenon, evolution depending on a change in ontogenetic rhythm (8, p. 387). According to this view nerve cell and germ cell both possess the property of being impressionable, the latter, of course, to a much lesser degree. The *engram* is the unit of impression, many of these being associated into various different groups, the whole completed system being called the "mneme," a Greek term equivalent to "memory." It is claimed that experiences, habits, will leave their traces upon the organism, the germ plasm only being fundamentally affected after a vast number of reinforced repetitions. The "imprint" having been made, later generations will show changes either in structure or function.

In this connection it is of interest to note the following remarks of Jennings (18): "As a material, potentially visible organism, I, like the infusorian, have been in existence ever since the race that developed into human kind began. And this, for each of us, is not a figure of speech, but the plain literal truth. An unlimited microscopist could have followed with his eyes my course, and your course, down through countless ages, never losing sight of the material organism for an instant. . . . I was in actual material existence as a living organism, and indeed thousands or millions of years old, when the pyramids were built, and my unlimited microscopist could give my history from that time to this without a break. What marks has that long history left on my personality and character?" (903–904.) It is this phylogenetic aspect we must keep in mind in studying the heredity of character and personality.

UNIVERSAL ANCESTRY

"Scientists have calculated that each of us of course has thousands of ancestors, and that frequent crossing of ancestral lines has occurred, so that practically every individual living today has among his ancestors *every individual* of the race who lived 5,000 years ago. So the ancestry of the race is practically

[1]Read before the twelfth annual meeting of the American Genetic Association at Berkeley, California, August 3, 1915.

common to all, hence the uniformity of the more elementary feelings and tendencies of the race. Each and every individual is heir to *all* the experiences of past generations" (Atkinson (2), p. 98–99).

With this feeble attempt at reorienting ourselves to the truly wide aspect of inheritance, we come to a weak spot in many a positive eugenic program. There is a tendency on the part of some to include in the list of hereditary characters certain mental, emotional and moral traits which seem to be the peculiar possession of particular families. The hereditability of the following have been maintained by various authors: tact, power of expression, lying, nomadism, endurance, stubbornness, bad temper, sentimentality, good judgment, morality, character, industry, criminality, affability, left-handedness, antipathy for physicians, fear of water, disgust for certain articles of food—*e.g.*, cheese. Heymans and Wiersma observed that parents and offspring resembled each other, among other things, in ardor, impulsiveness, resolution, persistence, generosity, temperance, wit, patience and industry. Davenport enumerates talents in music, art, literature, mechanics, invention, mathematics; the degree of sensitivity, quick or dull, keen or poor; the type of disposition, cheerful or melancholic; selfish or altruistic; conscientiousness or liability to shirk. "These characteristics," he says (10), "are inheritable; they are independent of each other, and they may be combined in any desirable mosaic" (p. 6). Crzellitzer's list of heritable traits includes ability in music, sculpture, painting and mathematics; thriftiness, temperament, liberality and military ability. He quotes the work of Fürst and Jung and their observations of family resemblances by means of the association-reaction method. But what they proved was *not* that certain common ideas or attitudes are inherited, but rather that developed family "complexes" exist. This question will be further elucidated later. Besides those characteristics already mentioned, Josefovici adds diplomacy and ability in science.

Pearson found such qualities as vivacity, conscientiousness, popularity, temper, introspection or self-consciousness, and assertiveness, to run in families. This may be coupled with the following interesting statement made by Davenport (9): The "boldness, swiftness, certainty of manipulation and that precise knowledge which belong to the great surgeon are not due to himself, but were, in their elements, antecedent to him. He could not help his valuable innate qualities, his knowledge is largely a heritage of the past, his education has been possible because of his educability and because of preexisting knowledge" (p. 38). One wonders how close Davenport came to saying that information and dexterity acquired in one generation are transmitted in the next.

WEAK POINTS IN RESULTS

Most of the above studies are of doubtful value because of any one or more of these reasons:

(1) Inaccurate tools with which to measure the ability or capacity.

(2) Amateur field-workers.

(3) The use of the questionnaire method.

(4) Where more than one field-worker was necessary to obtain the data, differences in the individual standards of the field-workers vitiated the results.

(5) Being told for what to look, and possessing the popular conceptions regarding the inheritability of all sorts of traits, it is only just to assume that many of the assistants very easily found what was not there.

(6) The study of character and personality is still in its infancy. To assume that certain peculiarities are due to the presence or absence of specific determiners can, in our present state of knowledge, hardly be substantiated by actual facts.

(7) Some students approach the problem of the inheritance of *mental* traits fresh from the biological laboratory. Without hesitation they will assume, for example, that the overzealous care of one's dress is a unit character, recessive to all appearances, acting in

Mendelian ratio, similar to hair color in certain animals.

Thorndike aptly remarks (36): "One fears that Professor Pearson may next produce coefficients of correlation to show that the political party a man joins, the place where he lives, and the dialect he speaks, are matters of pure inheritance uninfluenced by family training" (p. 242). It is due to these conceptions that it is so difficult to eradicate such false terms as "born criminal," "royal blood," etc.

One great weakness of all these studies has been that all have remained satisfied, it seems, in their belief that conscious phenomena presented to them the complete picture of the psyche. Psychologists generally are beginning to recognize more and more that consciousness is by far the less important, and that the great storehouse for *motives* to action is the unconscious.

"There is much of the cave-man even in the most cultured individual, which comes to the surface when opportunity presents itself and environment supplies the stimulus. Civilization is only skin-deep,—culture is only superficial. Beneath the thin veneer of our civilization lies the great mass of the race experience with all its primitive emotions, tendencies and impulses" (27, pp. 96, 97).

UNCONSCIOUS ACTIVITY

It might be well to cite some opinions on the unconscious at this point. In a recent book by Holt (17) we find the following: "Experimental psychology, then, should relinquish its fetish of introspection, at least until a great deal has been learned about the simpler conscious processes which introspection wots not of. . . . But the greater region lies unexplored by psychologists: it is those lower responses of the nervous system which psychology has hitherto been pleased to call 'unconscious' reflexes and automatisms, that a sound scientific instinct should select as being the simplest and hence the elementary processes of consciousness, out of which the more complicated processes are compounded,—even at last the self reflective" (p. 200).

Atkinson (27) quotes Sir Wm. Hamilton, who states: "I do not hesitate to affirm that what we are conscious of is constructed out of what we are not conscious of—that our whole knowledge in fact is made up of the unknown and incognizable. The sphere of our consciousness is only a small circle in the center of a far wider sphere of action and passion, of which we are only conscious through its effects. . . . The fact of such latent mental modifications is now established beyond a rational doubt; and on the supposition of their reality, we are able to solve various psychological phenomena otherwise inexplicable" (pp. 13, 14). This is in line with Stanley Hall's frequent remark that the psychic life may be compared to a floating iceberg: that which is visible is the conscious; and easily, nine-tenths of the whole mass remains submerged, unconscious. And it is being daily verified that by far the major portion of our mental life never enters the realm of consciousness. We would all be sad wrecks in but a very short space of time were all the mental activity of each successive moment to project itself into our conscious field.

In our studies of mental heredity we have placed consciousness and conscious phenomena on too high a pedestal. Ladd and Woodworth in their "Physiological Psychology" emphasize time and again the enormous handicaps which beset one in attempting to inquire into the elemental factors which go to make up our complex mental states, when either introspection or objective experimentation is used as the analytical instrument.

How dangerously simple then do some of our confreres make mental traits!

DIFFICULTY OF INVESTIGATION

Leibniz (21) was near stating the problem accurately when he said that "petites perceptions" determine our will fiats. Of course, interpreting his statement in modern terms we would say that unconscious ideas, constellations and complexes are some of the chief motivating factors of conduct.

Regarding the nature of the uncon-

scious it was Richard Herbetz (16) who made the remark that "we do not know *what it is*, but only what it *does*, and we do not know *how it does what it does*" (p. 217). But despite our lack of knowledge as to its exact nature, we do know quite definitely and certainly that the unconscious exists and that it is a potent force in directing behavior.

The Freudians and those closely allied to them have uncovered a large number of mental mechanisms whose roots lie in the subconscious. Data first obtained in gross form from those mentally disturbed were found to apply quite as well to people whose psyche was in normal activity. And the great contribution of the Zürich school to the psychology of today has been the discovery of the existence of the complex and the explanation of how it functions. Previous to this time all we could do was just to make disconnected observations such as that of Le Bon in his "Psychology of the Crowd:" "Behind the avowed causes of our acts there undoubtedly lie secret causes that we do not avow, but behind these secret causes there are many others more secret still, which we ourselves ignore. The greater part of our actions are the result of hidden motives which escape our observations." But now we know that the complex, once it is formed, becomes a potent, dynamic unit, and that some of these "blind impulses to action" are merely the inevitable result of its existence.

A complex, simply defined, is an associative arrangement of specific mental data, strongly tinged emotionally. Complexes may exist in the realm of the conscious, but are of as great, if not of greater, significance, when they sink below the limen of consciousness. Education, environment, home influences, exceptional experiences, age, sex, race, religion, certain hereditary predispositions, are among the most important factors determining the type, number and trend of one's complexes. (See 20, p. 548–554.) The recent research of psychoanalysts, whose testimony and data ought not to be ignored, has indicated the close and intimate relationship between such phenomena as forgetting, moods, character, likes and dislikes, ambitions, mental and physical ability, habits, the development of special aptitudes,—and the complex. The analyses of insane persons and criminals on the one hand, and those of geniuses, artists, poets, on the other, have shown that the type of complex in both groups is very much alike. These dynamic units, by the way, find their counterpart in the engrams of Semon's mneme, but it does not necessarily follow from that, that all complexes are inherited; some are, a large number are not.

INSTINCT AND REASON

In this connection, it might be well to mention that instinct, for example, is merely a mass of inherited complexes, and in terms of the mnemic theory, merely a group of engrams. The effect of one impulse acts as a stimulus to the second, the effect of the second acts as a stimulus to the third, and so on until the chain of action is complete. It is Hall (15) who indicates the superiority of instinct over reason, and his statement is of significance for us, since we are so liable to overemphasize the importance of conscious, superficial, intellectual factors over those which are unconscious, innate and organic. "The superiority of instinct over reason is that it regulates conduct in the interest of the species at every point, while consciousness is selfish and is exactly measured by the degree to which the individual has broken away from the dominance of the race and set up for himself against it" (p. 211).

The Freudian and Adlerian schools have already contributed a mass of material which is of enormous importance for the study of character and personality. One main achievement of the Zürich school has been the discovery that the principal roots of personality and character lie in the unconscious. Another valuable contribution was their proof that the early impressions of childhood were of enormous significance in the later development of the individual. Waldstein ably summarizes these two aspects in his article on the unconscious ego and

its relation to health and education (38): "What is often called heredity is merely the expression of the subconscious ego, whose origin can often be traced back to early childhood, to the time when the acts of the parents and their example left their impress in the unconscious" (p. 8, 9). Idiosyncracies of action, peculiarities, sympathies, antipathies, likes and dislikes, prejudices, preformed judgments, aggressiveness, passivity, marked artistic ability and tendencies, temperament, these and many more traits of character have been explained on the basis of acquired complexes. And as far as the evidence and explanations are concerned, they both seem quite valid. The significance of the powerful mass of "Triebe" and impulses in the unconscious must not be neglected by the careful student of heredity.

THE WORK OF ADLER

Disagreeing with Freud in certain essential details, Adler broke away entirely and, aided by his followers, continued his studies on normal and neurotic children. In its essentials his "minderwertigkeit" theory, to explain certain motives of conduct, is as follows: None of us is born with a system all of whose organs are perfect in structure or function. There is a weak spot somewhere. This will be manifested very early in life in defective reactions to the environment. An attempt, conscious or unconscious, will then be made to compensate for that defect, either by a symmetrical organ undertaking the extra labor; or by an entirely different organ adapting itself to care for the extra burden, the defective organ in both cases becoming hypertrophied; or, finally, by a hyperfunctioning of the inferior organ. This compensation activity may also be manifest in cases where organ-defect is not necessarily the basis. For example, a child lies about the occupation of its father, saying that he drives the king's carriage, when in reality he is a coal dispenser in very poor circumstances. The defect here is, of course, one of social position, and the extra activity of the imagination is induced to compensate for this defect. There is hardly time to go into his explanation of the "manly protest" and the "Aggressionstriebe," but on the basis of these compensating factors, Adler explains musical and artistic ability, the development of great orators and singers, miserliness, humility, the tendency to enter some particular profession, etc.

I regret being unable to make more than mere mention of the work of Swoboda and Fliess on the effect of periodicity in human behavior, and of the research of such men as B. Berliner, W. Schmidt, Lehmann and Pedersen, on the effect of weather conditions: changes in barometric pressures, winds, temperatures, atmospheric ionizations, solar radiations, etc., on the actions of mankind. Climatopsychology has already developed a fair-sized literature.

RESEARCH CAUSES OPTIMISM

Of course, all these fields are virgin. A great deal of further research is necessary. But as far as they have already developed, one gains much optimism from the growing belief that after all, those people who possess a peculiar trait which tends to make them more or less unsocial, *e.g.*, bad-temper, or the tendency to lie, are not necessarily doomed to suffer this defect all through their lives, to be avoided in marriage by those who make eugenics their religion, but that rather by means of a proper therapeusis, by a proper handling of the environmental, unconscious, as well as hereditary factors, these harmful expressions can be harnessed, "sublimated," and the energy driven into a different, more socially-advantageous channel.

In closing this paper I wish to bring to your attention, in view of the above-mentioned facts, a typical study of a so-called mental trait, namely musical ability. To begin with, no psychological analysis was made to determine what constituted musical ability. The conclusions as to its heritability were based upon the returns of questionnaires filled out by professional men, farmers and business men,—people hardly qualified to make an accurate judgment of the matter. Personally, I wonder what standard was used. Was a person considered possessed of musical ability if he were able to sit through a musical comedy or

a burlesque show, and on his return home whistle half the tunes over to you, or was only he regarded as being musical who could perform that feat after attending a symphony concert or a Wagnerian opera? So much for the receptive type. Or perhaps none of the receptive type was classified as musical, those only who were creative being qualified to be designated as such. Well, then, if that were the case, was he considered musically artistic who could, in half an hour or so, compose a catchy piece of "rag-time," or was it only he who after labored efforts produced a classical masterpiece? Were there among our judges any who considered Wagner's music an abomination of discord, and regarded an idolizer of that German's genius, an ignorant boor? Yet, whatever the conditions and standards, the following were the conclusions: "When both parents are exceptionally good in music (whether vocal or instrumental), all the children are medium to exceptionally good." Hurst's explanation that musical ability acts as a recessive was accepted. "When both parents are poor in musical ability and come of ancestry that lacks on one or both sides such ability the children will all be non-musical." "When one parent has high musical ability and the other has little the children will vary very much in this respect."

If we really have been as careless in our methods as it seems, ought we resent the criticism of our English confreres, or ought we not better mend our ways and be a bit more cautious in the future?

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Variation in Pure Lines

The Ohio Agricultural Experiment Station has been studying variation in pure lines of wheat since 1907, the characters under observation being size of kernel, length of head, tillering and protein content. Each year 1,000 heads of wheat and oats are selected and perpetuated as pure lines, in order to find more desirable varieties of these cereals, if any such exist. Similar work is being done with soy beans, but not on such a large scale. Hybridization of corn and tobacco is also under way.

The search for variation in a pure line has not yet been productive of any important result. C. V. Williams sends the following note:

"The fifth crop of wheat harvested in our high and low protein work gives the following results:

		Percent. protein
Fultz pure line	High protein selection	13.02
	Low protein selection	12.46
Poole pure line	High protein selection	14.10
	Low protein selection	13.52

The average protein content of the seed used for the five seasons is:

	Fultz	Poole
High protein	17.43%	17.94%
Low protein	12.01	12.02

This will have to be continued some years longer before we shall know whether this apparent variation is heritable or not. Three years of the work are reported in A. B. A., Vol. 8, p. 409."

APPLE BREEDING IN IDAHO

Needs of State Lead Experiment Station to Undertake Production of New Varieties on Large Scale—Preliminary Report on Crosses Made—Burbank's Method of Selecting Seedlings[1]

C. C. VINCENT

Agricultural Experiment Station, Moscow, Idaho

BY the Adams Act, approved March 6, 1906, funds were made available for research work along agricultural lines in the state experiment stations. This fund made it possible for a number of stations to undertake plant breeding projects. Horticulturists realized that if there was to be progress in fruit growing, new and better varieties must be developed. The discovery in 1900 of Mendel's Law establishing some elementary formulas of heredity had given impetus to this work. Hence, during the past ten years, rapid advances have been made in many states; and one of the fruits to which especial attention has been devoted is the apple.

The need of such work is apparent. Previous to this time, but very little careful apple breeding work had been done. In a recent bulletin from the Geneva Experiment Station, Professor U. P. Hedrick says: "Of the 698 varieties described in the apples of New York, both male and female parent are certainly known for only one variety; one parent is known and the other guessed, for two other kinds; four are held to be sports from known varieties; and the female, or seed producing parent is given for thirty-nine kinds. Of the 650 varieties, seventy-one are said to be seedlings (of unknown parentage); but for the great majority of the kinds, nothing is positively known as to the origin. This poor showing for scientific, commercial or careful amateur apple breeding is due to several causes: Breeding tree fruits of any kind is time-consuming and space-demanding; the pecuniary rewards for individuals are inconsiderable or altogether wanting; institutions organized to do plant breeding have felt obliged to work in other fields where results could be more quickly secured and would mean more when obtained; and lastly, plant breeding, especially breeding of tree fruits, has until recently seemed largely a matter of guess work and chance—a process most of whose fundamental laws were unknown."

Of recent years, a number of stations, especially New York (Geneva), Iowa, Minnesota, South Dakota and Idaho, have trees from hand-crossed flowers of which both parents are known. The work at the Idaho Experiment Station has progressed along definite lines. The object of the work has been the improvement of existing varieties of apples by breeding.

NEW VARIETIES NEEDED

The need of winter varieties of apples, superior to existing types, has been keenly felt by those interested in the culture of this fruit. There are many varieties already grown that have many desirable characters, but no one of them combines all of these good features.

The Jonathan, for instance, has the color and quality to make it a prized dessert apple, but its keeping quality is not the best and it is especially bothered with storage scald and "water core." It is also very susceptible to blight. Likewise, the Ben Davis has its desirable and undesirable features. It is a great producer, the apples are good keepers, the trees late in blooming, remarkably thrifty and free from disease. The fruit is thick-skinned and is not easily

[1] Read before the twelfth annual meeting of the American Genetic Association, August 5, 1915, at Berkeley, Cal.

bruised in shipping. On the other hand, the fruit lacks in crispness, juiciness, flavor and texture, required to make it greatly prized either for home or market use. A great drawback in northern latitudes to the Ben Davis is that it is so late maturing that proper coloring is not secured except in exceptional cases.

The good and bad points of many other varieties might be mentioned, but what has already been said will serve to show the need of combining the desirable qualities of different varieties so that one variety may stand preëminently in the lead. In this connection, it should be mentioned that varieties of apples display many different types. Some trees are hardier, resist disease better, have better colored fruit, are later blooming and produce fruit of much better quality than do other trees of the same variety under the same cultural conditions. Thus in our work, we have taken these factors into consideration, with a hope that these desired characters may be intensified to their maximum extent.

For this improvement, the Ben Davis variety has been taken as a basis, using it as male and female. Crosses have been made with other varieties and from the resulting hybrids those will be selected that give promise of being adapted to conditions here.

METHOD OF OPERATION

The methods of securing cross pollinated fruits are much the same as those followed by plant breeders in general. The unopened blossoms are emasculated and pollen from other varieties applied when the pistils are receptive. Usually two emasculated blossoms are left to the cluster. In the fall the pollinated apples are harvested and kept in common storage until Christmas. They are then brought to the laboratory and the seed removed.

The seeds from each cross are separated from the fruit, given a serial number and tied in muslin bags. These bags are put in 2-inch pots, placed in flats and buried where they are exposed to freezing weather. As a precaution against destruction by mice, the flats have always been covered with screen wire. Late in February the flats are brought to the greenhouse and the seed germinated. By subjecting the seed to the above conditions, we have been able to get approxiamtely 95% germination. By the middle of May, the seedlings are from 10 to 12 inches in height; they are then transplanted to the nursery, in rows 3 feet apart, trees 6 inches apart in the row. The second season, the seedling trees are transplanted to their permanent places in the orchard, 6 feet apart each way. The results obtained thus far are as follows:

1910. During the spring of 1910, a total of 1,175 crosses was made. The seed taken from the fruit of these crosses produced 146 seedling trees. The parentage of these crosses follow:

Cross Female		Male	Number of Trees
Ben Davis	x	Jonathan	64
Ben Davis	x	Spitzenberg	55
Ben Davis	x	Ben Davis	2
Ben Davis	x	Wagener	3
Jonathan	x	Ben Davis	14
Winesap	x	Ben Davis	1
Jonathan	x	Jonathan	1
Wagener	x	Ben Davis	4
Delicious	x	Jonathan	2

1911. A total of 3,000 crosses were made in the spring of 1911. From the seed of fruits crossed this year, a total of 1,920 healthy seedlings trees were secured. The crosses made and the number of trees secured from each cross follow:

Cross Female		Male	Number of Trees
Jonathan	x	Ben Davis	916
Wagener	x	Ben Davis	280
Ben Davis	x	Jonathan	301
Spitzenberg	x	Ben Davis	121
Ben Davis	x	Spitzenberg	62
Jonathan	x	Jonathan	1
Rome Beauty	x	Ben Davis	2
Ben Davis	x	Wagener	6

1912. Due to unfavorable climatic conditions, only 1,703 crosses were made. We were very successful in germinating the seed taken from these fruits and the results were that 3,065 seedling trees grew. The number of trees from each cross is as follows:

Female	Cross	Male	Number of Trees
Ben Davis	x	Jonathan	508
Jonathan	x	Ben Davis	1,042
Ben Davis	x	Wagener	181
Wagener	x	Ben Davis	551
Jonathan	x	Wagener	175
Wagener	x	Jonathan	485
Jonathan	x	Spitzenberg	57
Spitzenberg	x	Jonathan	66

1913. In the spring of this year, 2,823 crosses were made. One thousand four hundred and seventy healthy trees grew from these crosses. The following table shows the number of seedlings secured from each cross:

Female	Cross	Male	Number of Trees
Jonathan	x	Ben Davis	603
Jonathan	x	Wagener	500
Ben Davis	x	Jonathan	314
Ben Davis	x	Wagener	53

1914. During this year, 2,527 crosses were made. From this number 4,544 healthy seedlings were grown.

Female	Cross	Male	Number of Trees
Gravenstein	x	Newtown	22
Gravenstein	x	Jonathan	20
Spitzenberg	x	Ben Davis	153
Spitzenberg	x	Rome	28
Spitzenberg	x	Jonathan	80
Spitzenberg	x	Newtown	66
Spitzenberg	x	Wagener	238
Ben Davis	x	Spitzenberg	107
Ben Davis	x	Wagener	23
Ben Davis	x	Rome	147
Ben Davis	x	Newtown	57
Jonathan	x	Spitzenberg	542
Jonathan	x	Wagener	391
Jonathan	x	Newtown	68
Jonathan	x	Rome	42
Jonathan	x	Arkansas Black	147
Wagener	x	Spitzenberg	41
Wagener	x	Rome	818
Rome	x	Ben Davis	241
Rome	x	Spitzenberg	337
Rome	x	Wagener	326
Rome	x	Newtown	631
Arkansas Black	x	Jonathan	5
Newtown	x	Spitzenberg	8
Newtown	x	Wagener	6

Summary: To date, there are 10,915 hybrid seedlings growing in our orchard and station nursery. The total number of trees secured from each cross is as follows:

Female	Cross	Male	Number of Trees
Ben Davis	x	Jonathan	1,187
Ben Davis	x	Spitzenberg	224
Ben Davis	x	Wagener	266
Ben Davis	x	Rome	147
Ben Davis	x	Newtown	57
Ben Davis	x	Ben Davis	2
Jonathan	x	Ben Davis	2,575
Jonathan	x	Wagener	1,066
Jonathan	x	Spitzenberg	599
Jonathan	x	Jonathan	3
Jonathan	x	Arkansas Black	147
Jonathan	x	Newtown	68
Jonathan	x	Rome	42
Spitzenberg	x	Ben Davis	274
Spitzenberg	x	Rome	28
Spitzenberg	x	Newtown	66
Spitzenberg	x	Wagener	238
Spitzenberg	x	Jonathan	146
Wagener	x	Ben Davis	835
Wagener	x	Spitzenberg	41
Wagener	x	Rome	818
Wagener	x	Jonathan	485
Rome	x	Ben Davis	243
Rome	x	Spitzenberg	337
Rome	x	Wagener	326
Rome	x	Newtown	631
Arkansas Black	x	Jonathan	5
Newtown	x	Spitzenberg	8
Newtown	x	Wagener	6
Gravenstein	x	Newtown	22
Gravenstein	x	Jonathan	20
Delicious	x	Jonathan	2
Winesap	x	Ben Davis	1

This material will give us a splendid opportunity to study fundamental principles, useful in plant breeding. We are trying to find correlations and are working along the lines recommended by Luther Burbank. In a recent communication from Mr. Burbank, he says: "In selecting apple seedlings, my practice has been first of all to select those which do not mildew—this can be easily done while they are young. This eliminates one of the worst qualities in apple seedlings. Next, I thin out all the very slender growers with small deeply cut leaves. These always tend back to the wild state. In the next selection, I give preference always to those having large fat round buds, large thick leaves and a stocky growth."

Such a procedure will enable the plant breeder to discard undesirable seedlings without having to grow each plant through to maturity in order to determine its characters.

DOUBLE SEEDING PETUNIAS

Crossing and Selection Result in Production from Single and Imperfect Double Types of Four Strains That Are Double and Produce Seed—Methods of Operation—Curious Variations Observed[1]

MRS. MYRTLE SHEPHERD FRANCIS, *Ventura, Cal.*

BEFORE presenting the subject of my double petunia that reproduces itself, I want to state that I claim no scientific attainments, that while the scientific aspect of the work has been of deep interest to me my chief aim has been to produce the finest strains of double petunias to be had in the market and to make those strains reproduce themselves. Competent authority assures me that my work has been successful.

Data regarding the crossing of both single and double petunias is exceedingly difficult to obtain as most of it is scattered about in horticultural reports and magazines.

The first single petunia was found by Commerson in Argentina, on the banks of La Plata River, and sent by him to Jussieu, who named it *Petunia nyctaginaflora*, introducing it into France in 1823. This plant had an upright habit with thick sticky leaves and long-tubed fragrant white flowers. The second species was sent by Tweedie from Buenos Ayres to the Glasgow Botanical Gardens in 1831. This plant had a decumbent habit, small violet purple flowers and short tube and was named *Petunia violacea*. From these two species all varieties of petunias have been bred. They have been freely crossed with each other; hence the garden varieties now go under the general name of *Petunia hybrida* Hort.

While the nyctaginaflora type is quite common, the true violacea form is seldom seen, proving that the nyctaginflora species was the dominant factor in the early crosses. Even today most varieties revert to that form when left to themselves.

For convenience sake I shall loosely divide the single varieties now under various names into two classes: those with upright habit, long-tubed flowers with small reproductive organs, slender style and filament adherent low down in the corolla tube and wide range of colors with satiny texture, as hybridas, representing *P. nyctaginaflora;* and the varieties with the decumbent habit, large leaves, flowers with short tube, large reproductive organs, thick style and filament adherent high up in the corolla tube and limited range of colors, as representing *P. violacea.*

The first double petunia appeared in a private garden in France in 1855 and from this, so far as I have been able to learn, have all other doubles been obtained by artificial fecundation.

METHOD OF OPERATION

For the benefit of those in this audience who may be unfamiliar with the method by which double petunias are obtained I will explain, that the double is an imperfect flower and the single is a perfect flower. The unbroken anthers (the pollen-bearing organs) of a single flower are removed, the flower is then covered with gauze or paper until the stigma is ready, the pollen is then applied from a double flower by means of a camel's hair brush and the covering replaced, to prevent the possibility of insect fertilization.

Such a procedure, however, is entirely too laborious for commercial work. I have never used the coverings but remove the anthers and pollenize at once from a nearby flower, double and single plants being grown in adjoining plots.

[1] Read before the twelfth annual meeting of the American Genetic Association, at Berkeley, California, August 6, 1915.

FEMALE PARENT OF THE CROSS

Petunia grandiflora, shown above, natural size, is single and has perfect reproductive organs, producing several hundred seeds from each flower. So far as she can learn it had not been used in commercial production of double-flowering petunias until Mrs. Francis began to work with it, all breeding have previously been done with various forms of *Petunia hybrida*. (Fig. 6.)

From the size of anthers and stigma, colors and habit of growth it would seem that the hybrida had been universally used for both male and female parents, until recent years.

Though advised otherwise, in my early work I chose the form known as grandiflora as the female parent for my doubles, probably because the flowers were easier to work with. Later when an ideal had formed itself in my mind the grandiflora seemed more likely to give the desired results.

Many doubles have rudimentary organs of reproduction, but in my first work in 1901 I noticed this and formed the habit of examining each bloom carefully before picking it to pollenize with.

The first perfect double bloom was found on a hybrida plant in 1910. This plant had delicately fluted flowers with cream colored pollen and, when pollenized with another flower from the same plant, matured a capsule of seed. The stamens of this flower were many, rising directly through the center, the filaments being bound together by a band or collar, while the ovary sat upon a torus. The ovary of the single form sits directly upon the calyx.

From this capsule of seed thirty-seven plants were raised. No records were kept until 1911, but as near as I can remember about 75% were double, both single and double being of the hybrida type. None of these plants gave many perfect flowers though all were examined for reproductive organs and some seven or eight matured seed.

That season among our regular doubles appeared a semi-double of steel blue and white which bore all perfect flowers, and on an inferior double red was found a capsule of seed which had matured without hand pollenizing.

From these three distinct types 660 plants resulted in 1912, 85% double and 22% seeding slightly.

GREAT VARIABILITY

The petunia is perhaps the most variable flower under cultivation but its fluctuations have a certain regularity. In this generation, the three types being planted together, the wildest confusion prevailed. In it appeared for the first time the true grandiflora, represented by three plants of deep magenta color with steel-blue pollen. Their doubling was of an entirely different nature,—all extra petals were adherent to the corolla tube instead of the usual mass of petals and stamens which generally fill the center of the flowers. Nearly all blooms on these plants were perfect, though they did not all mature seed.

In this planting were also some very small inferior doubles of dingy purple flowers, which were perfect with the same manner of doubling and which matured several capsules of seed without pollenizing. Both extremes have the same form and both are fertile.

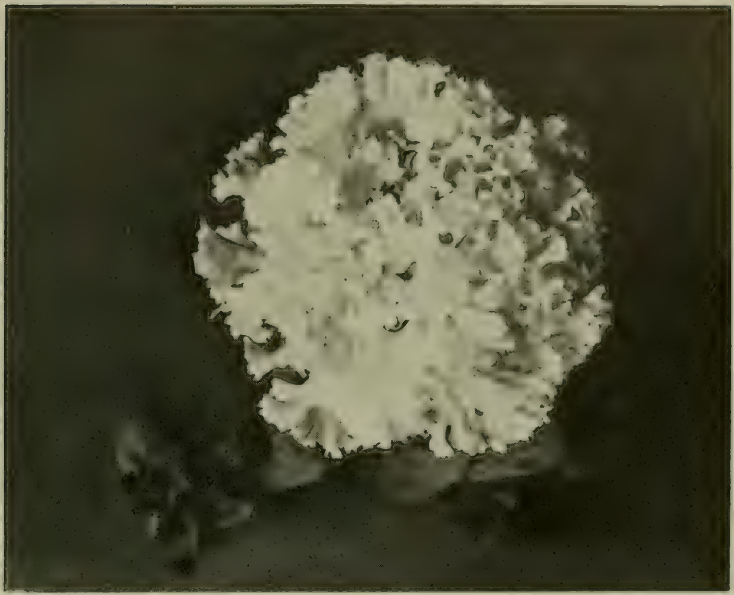
From the grandiflora crossed by the hybrida double and some seed of the hybridas also we raised in 1912, 510 plants, 73% in double, 25% seeding. Many of the flowers showed great variety of color, beauty and size.

In 1913 we got 187 plants with 73% double but 33% seeding. This year marked a decided change, the grandiflora heretofore recessive became the dominant type with blooms of extraordinary size, while its seeding capacity had increased 8%. Both beauty and reproductiveness had developed to such an extent that for our stock seed I crossed a perfect double with a perfect double for the first time, but disaster overtook me for our seed beds with our entire stock of seedlings were washed out by the floods of 1914.

Replanting from our selling stock yielded 918 plants, 85% double, 42% seeding. 1915 produced 567 plants, 90% double, 40% seeding. While the increase of doubles has been quite steady the seeding precentage has not increased so rapidly due to the use of a plant that carried singleness in its pollen but with other qualities which I wished to preserve.

I have not yet made the reciprocal cross again but expect to do so this season, as many of the fine large flowers are perfect, seeding as freely as singles when pollenized.

Doubtless my work would have been done on entirely different lines had my



DOUBLE FORM OF HYBRID PETUNIA

This was used as male parent in Mrs. Francis' crosses. The first double petunia appeared in 1855, and since then they have been steadily produced, but as the doubles produced pollen but could not set seed, it was necessary to create them by a new cross each year, since they could not reproduce themselves. Doubles had to be crossed on singles, the latter then bearing seed which produced a small proportion of double flowers. Mrs. Francis undertook to produce a strain of doubles that would not have to be crossed on singles this way each year, but would be capable of bearing seed. For this purpose she crossed the above hybrid form with the giant-flowering form shown in Figure 6. The result has been successful: not all the double flowers produce seeds, but enough of them do to make the culture commercially profitable. (Fig. 7.)

knowledge been greater in the beginning. During the last five years I have bred four distinct strains of double seeding petunias, steadily increasing doubleness, lengthing the stems, and giving greater delicacy to the texture and colors. In all my work those qualities have had precedence over reproductiveness.

Many interesting and curious variations have been observed, in one of which the whole flower becomes petalous. Some of the finest flowers are pistillate, reversing the old form, others have anthers containing no pollen, while some almost single blooms have malformed reproductive organs, still others are perfect but infertile, etc.

Lavender and steel blue seem to be the best seed producers and I am quite sure that blue pollen is more productive of fertility in doubles than yellow, which continues to give about 25% seeding plants. This may be due to the contracted throat which seems to accompany this pollen.

Of volunteers which appear each season the doubles predominate. I have never found one with other than blue pollen.

The small pointed capsule of the hybrida containing about 250 seeds has developed with the flower, one capsule often producing as many as 450 seeds. The dehiscence in singles is in twos but in these doubles it is often in threes and fours.

In conclusion I quote from De Vries *Species and Varieties:* "Hays has repeatedly insisted upon the principle of the choice of the most favorable variety

ONE RESULT OF FIVE YEARS OF BREEDING

By crossing the two forms shown in the preceding photographs, one single and producing seed, the other double and producing no seed, Mrs. Francis was able to get forms like this, which are not only double but produce seed as well. They are, therefore, a great improvement over the previously known double forms, from the gardener's point of view. In spite of this, reproductivity has been only a secondary object of the breeding, most attention having been given to improving the shape and color along lines that would be likely to appeal to the lover of this very variable member of the potato family. (Fig. 8.)

for the experiments in improving races. He asserts that half the battle is won in choosing the variety which is to serve as a foundation stock, while the other half depends upon the selection of parent plants within that variety." I blindly striving to realize my ideal unconsciously chose the most favorable variety and the right parents in that variety for what I desired to produce, and if the entire stock of these strains should be lost, with my present knowledge I could consciously choose the right variety and the right seed parents in that variety and other strains of seed producing double petunias could be developed.

Heredity in the Soy Bean

Inheritance of chemical characters of the soy bean is under investigation at the Wisconsin Agricultural Experiment Station, while the experiment is also being used to bring to light the mode of inheritance of morphological characters. A similar investigation relates to Datura, the primary object of which is to learn how the alkaloidal content of the plants is influenced by heredity. The usual practical lines of breeding of old or new varieties are also carried on.

Hybrid Histology

Histological study of hybrids, a subject too much neglected by genetists, is reported from the Mississippi Agricultural Experiment Station, particularly with reference to interspecific crosses of tobacco, and a cross between the radish and kohlrabi. A study of the cells of hybrids shows that in many cases the supposed dominance visible in external characters is more or less of an illusion. Of 121 characters of hybrid plants studied in this investigation, it was found that 100 were intermediate between those of the two parents. "A hybrid character that appears to show pure dominance may upon close examination be found to be intermediate if its structural basis be examined." This was one of the early discoveries of the pioneer genetists who submitted Mendel's laws to such critical tests, following their rediscovery in 1900; but since then most plant breeders have followed the evidence of the unaided eye, and failed to look below the surface when pronouncing on the dominance or lack of dominance of any character. "The xylem of the root of the radish by kohlrabi hybrid illustrates this; the central part of this root when examined *macro*scopically appears to be dense wood, as dense as the wood of the central part of the root of the kohlrabi parent, but if this xylem is examined *micro*scopically it is found to have a considerably larger per cent. of thin-walled, unlignified cells, thus presenting a structure intermediate between the two parents." It may be added that this work, reported in Technical Bulletin No. 3 of the Mississippi station, was actually performed in the laboratories of Cornell University by Harry B. Brown.

More Profit from Grains

Tests of wheat and oat varieties are an important part of the Indiana Agricultural Experiment Station's work. The latter study has been carried on for ten years, and the average yield of the ten highest varieties has been computed as 12.3 bushels more per acre than the average of the ten lowest varieties. This difference, as the station is busy pointing out to the farmers, is sufficient to pay for nearly one-half the cost of producing the crop.

ORIENTAL IMMIGRATION

Problem of Immigration on Pacific Coast of Much Less Importance to Eugenics Than That on Atlantic Coast, Because Intermarriage is Rare—How the Immigration Laws Work[1]

W. C. Billings

Surgeon, U. S. Public Health Service; Chief Medical Officer, Immigration Service, Angel Island (San Francisco), Cal.

FROM the viewpoint of eugenics alone the administration of the immigration law (including the Chinese Exclusion Law) is not so important, because not so far reaching, on the Pacific coast as the execution of the same laws at ports situated upon our eastern boundary. It may be of as great, or possibly even greater, importance upon the Pacific coast if viewed from other standpoints,—for instance that of economics, standards of living, and possibly, in the opinion of a considerable number of people, that of simple fairness. The reason for the lesser degree of living interest, in so far as the application of the laws mentioned bear upon the subject of eugenics, is simple, and is tersely put by the man who has the ability, in such a pre-eminent degree, of sensing the feelings and attitudes of all sorts of peoples, when he says "and never the twain shall meet."

The application of this expression to the problem of eugenics and the administration of the Immigration Law upon our west coast, which really amounts to saying the problem of eugenics in its relation to the citizens of our country and the Oriental, is not in the slightest degree a reflection upon the peoples of any of the countries concerned,—it is simply an expression used in an explanatory way to accent the point that, as a purely eugenic consideration, the execution of the immigration law upon the Pacific coast is not of very great moment for the very simple reason that, upon both sides, there seems to be, speaking broadly, absolutely no disposition to inter-marry.

In the opinion of the Rev. B. C. Howorth, who spent nineteen years in Japan as a missionary, and who for the last eight years has been employed by the United States Immigration Service as Japanese interpreter, there are on our whole Pacific coast not more than twenty instances of intermarriage between Americans and Japanese, and in the opinion of John Endicott Gardiner, for sixteen years resident in China and for thirty years Chinese Inspector in the United States Immigration Service, one might count on the fingers of both hands the number of American-Chinese marriages between San Diego and Seattle. Both of these men are in close touch, respectively, with Japanese and Chinese matters and conditions and are able to give an approximately accurate estimate of the extent of intermarriage.

CONTRAST ON TWO COASTS

The immigration received at our Atlantic ports, while certainly racially heterogeneous enough to satisfy the most extreme longing for variety, still admits, and as time goes on will admit more and more, of an opportunity to study from a eugenic standpoint the ultimate product of the "melting pot." The explanation of this opportunity is as simple as is the explanation for the lack of opportunity previously spoken of,—it is simply that, given propinquity, Occidental races will intermarry to almost any extent, but under such

[1] Read before the twelfth annual meeting of the American Genetic Association, August 3, 1915, at Berkeley, California.

conditions as have so far existed in the United States the Occidental exhibits no tendency to intermarry with the Oriental and that lack of inclination seems to be entirely mutual.

The administration of the immigration laws at California ports is supposedly the same as at all ports of entry located wherever they may be, with the addition of the Chinese exclusion law. Naturally the last named law applies at certain other places, but it is at those ports situated upon the Pacific coast that the opportunity, or necessity, for its greater scope exists.

The expression "ports of entry" used in an immigration sense must not necessarily be connected in one's mind with seaboard cities alone,—it means any place where the Immigration Service has its officers regularly located, and may be a thousand miles from the coast. There are, for instance, sixty-five places stretched along the Canadian border through any of which aliens may lawfully enter the United States provided they present clearly their eligibility to do so, and twenty-five of these places have what are called "boards of special inquiry" for the consideration of those cases in which the right to land, under the immigration laws, is not clearly established. On the Mexican border thirteen ports of entry are located.

All ports of entry consider the application for entry to our country of all aliens, from any country whatever, with the one exception of Chinese, while certain cities are designated as Chinese ports of entry and any Chinese not entering through one of them is surreptitiously in the United States; these places are San Francisco and San Diego, Cal.; Portland, Ore.; Boston, Mass.; New York, N. Y.; New Orleans, La.; Port Townsend and Seattle, Wash.; Tampa, Fla.; Honolulu, Hawaii and San Juan and Ponce, P. R.

In considering the administration of the Immigration Laws at California ports we have then to consider San Francisco, San Diego, Andrane, Campo, Calexico and Tia Juana, and to bear in mind that while there are two laws, one called the Immigration Law and the other the Chinese Exclusion Law, they both, from any but an official standpoint, are alike in their aim and result, namely, the keeping of undesirable aliens out of the United States.

The immigration to California ports is, broadly speaking, entirely Oriental, consisting of Japanese, Chinese, Koreans and Hindus, the number of arriving aliens of Occidental lineage being so small that for the purposes of this paper they may be disregarded.

All aliens, including of course Orientals, have to comply with the general requirements of the immigration laws, but in a certain sense the arrivals at California ports have to go somewhat farther in that the Chinese have to meet the restrictions of the Chinese Exclusion Law, while our Government has an agreement with the Japanese governmet regarding a certain type of Japanese immigrant.

EVOLUTION OF THE LAWS

The immigration laws of our country have evolved gradually and changes have been made from time to time in order that they may meet conditions not existing, or not realized, at the time of their framing. To the organic laws must be added such interpretations and constructions of them as have been made by various departmental officials and the resulting total presents at times a rather difficult and intricate executive problem, especially if it be borne in mind that the humanitarian aspect is a factor that cannot, and should not, be overlooked, because in the application of these laws we are not deciding something concerning inanimate chattels but are dealing with human beings who have done no wrong and whose hopes and fears and aspirations are the same as ours.

The first immigration act was approved March 3, 1875, and the last March 4, 1913. Between the two there have been eighteen acts amending, either by elimination or addition, some portion of acts previously passed. The law as it stands today consists, we may say for the sake of clearness, of two portions—namely, the portion bearing

directly upon the moral, social and financial condition of the alien and his past history in regard to these conditions, or in other words, to coin an expression, his "immigration status;" and the medical portion, which concerns itself entirely with the mental and physical condition of the immigrant.

Quoting from Section 2 of the Act of February 20, 1907, as amended by the Acts of March 26, 1910, and March 4, 1913, "the following classes of aliens shall be excluded from admission into the United States: . . . Paupers; persons likely to become a public charge; professional beggars, . . . persons who have been convicted of or admit having committed a felony or other crime or misdemeanor involving moral turpitude; polygamists, or persons who admit their belief in the practice of polygamy; anarchists, or persons who believe in or advocate the overthrow by force or violence of the Government of the United States, or of all government, or of all forms of law, or the assassination of public officials; prostitutes, or women or girls coming into the United States for the purpose of prostitution or for any other immoral purpose; persons who are supported by, or receive in whole or in part the proceeds of prostitution; persons who procure or attempt to bring in prostitutes or women or girls for the purpose of prostitution or for any other immoral purpose; persons hereinafter called contract laborers who have been induced or solicited to migrate to this country by offers or promises of employment or in consequence of agreements, oral, written or printed, expressed or implied, to perform labor in this country of any kind, skilled or unskilled; those who have been, within one year from the date of application for admission to the United States, deported as having been induced or solicited to migrate as above described; any person whose ticket or passage is paid for with the money of another, or who is assisted by others to come, unless it is affirmatively and satisfactorily shown that such person does not belong to one of the foregoing excluded classes and that said ticket or passage was not paid for by any corporation, association, society, municipality, or foreign government, either directly or indirectly; all children under 16 years of age unaccompanied by one or both of their parents, at the discretion of the Secretary of Labor or under such regulations as he may from time to time prescribe: Provided, That nothing in this Act shall exclude, if otherwise admissible, persons convicted of an offense purely political, not involving moral turpitude: Provided further, That the provisions of this section relating to the payments for tickets or passage by any corporation, association, society, municipality, or foreign government shall not apply to the tickets or passage of aliens in immediate and continuous transit through the United States to foreign contiguous territory; and provided further, That skilled labor may be imported if labor of like kind unemployed cannot be found in the country: And provided further, That the provisions of this law applicable to contract labor shall not be held to exclude professional actors, artists, lecturers, singers, ministers of any religious denomination, professors for colleges or seminaries, persons belonging to any recognized learned profession, or persons employed strictly as personal or domestic servants."

It will be seen that the portion of the law which has just been quoted relates to what I have called the "immigration status" of the alien. The medical portion of the same paragraph of the law reads as follows, "The following classes of aliens shall be excluded from admission into the United States: All idiots, imbeciles, feeble-minded persons, epileptics, insane persons, and persons who have been insane within five years previously, persons who have had two or more attacks of insanity at any time previously; persons likely to become a public charge, persons afflicted with tuberculosis or with a loathsome or dangerous contagious disease; persons not comprehended within any of the foregoing excluded classes who are found to be and are certified by the examining surgeon as being mentally or physically defective, such mental or physical defect being of a nature which may affect the ability of such alien to earn a living . . . "

In the general application of these provisions of the law at San Francisco, at which port over 90% of the work of California ports is done, the arriving aliens are examined as to what I have called their immigration status by Inspectors of the Immigration Service, who are appointed to that position after civil service examination, and physically by Medical Officers of the United States Public Health Service who are assigned to temporary duty as medical advisers to the Commissioner of Immigration.

These men board all incoming passenger ships from foreign ports immediately after the vessel is given pratique by the quarantine officer and while the immigration officers are busy determining whether or not there are any persons among the passengers who are exempt from immigration examination, such as United States citizens,

foreign government officials and their suites, and in selecting such persons as unquestionably conform to all the requirements of the law, so that they may release such persons immediately from the ship, the medical officers are closely scrutinizing the first cabin passengers with a view to determining whether or not they present symptoms of any of the diseases which are mandatorily excludable. If no such symptoms are observed, and the immigration officers have found nothing undesirable or questionable, permission to land directly from the ship is given. The medical officers then conduct an examination of the crew to determine whether or not any of them present symptoms of a loathsome or dangerous contagious disease. In the event that they do they are not allowed to land while in port and are taken back to the country from whence they came on the return voyage of the vessel. At the present time all second cabin and steerage alien passengers from all ports in the orient are taken from the ship to the immigration station on Angel Island, where a much more thorough physical examination is made than is possible on shipboard.

VOLUME OF IMMIGRATION

Fiscal year ending	Males	Females	Total	Photo brides
1905	598	209	807	133
1906	594	218	812	121
1907	1,063	329	1,392	238
1908	432	188	620	112
1909	267	222	489	146
1910	376	348	724	266
1911	842	1,028	1,870	845
1912	1,165	1,436	2,601	1,230
1913	1,863	1,529	3,392	1,317
1914	2,018	1,856	3,874	1,595
Grand totals	9,218	7,363	16,581	6,003

Because our Government and the Government of Japan have an agreement whereby Japan will not issue passports to laborers, and if a Japanese arrives without a passport the burden of proof that he is not a laborer rests upon him, and we have the Chinese Exclusion Law, it very naturally seems to many people not familiar with the conditions that Oriental immigration would not be in sufficient numbers to be of much interest. Such, however, is not an actuality as there are so many exceptions.

All Japanese, except laborers, may come to the United States, and the result in numbers arriving at the port of San Francisco alone, for the last ten years is shown in the preceding table. During the corresponding ten years the total number of aliens of all nationalities admitted at San Francisco was 76,240.

The column headed "photograph brides" represents one of the most interesting classes of Japanese immigration although the term is, strictly speaking, a misnomer inasmuch as a photograph although, very naturally, often exchanged, is in no way a necessary or indispensable part of the arrangement. The term "proxy brides" which is frequently applied to the same class is, in so far as it implies the presence of a third party, also a misnomer, as, properly speaking, there are no proxy marriages in Japan.

The agreement referred to between the American and Japanese Governments to stop the emigration of laborers was made in 1908 and at that time a very considerable number of Japanese laborers were domiciled in this country, particularly upon the Pacific coast. Section 37 of the law already quoted allows domiciled aliens to bring their wives to join them and these men very naturally take advantage of the privilege. Marriage in Japan is arranged by the parents of the contracting parties and consists of removing from the register of her own family the name of the bride and adding it, in the official register of the administrative district in which he lives, to the names of the family of the groom. There is no civil or religious ceremony unless the contracting parties happen to be Christians. The ceremony of removing the name is followed by a social gathering of friends and assumes a congratuatory character.

This custom, which constitutes the legal marriage of Japan, can be followed even through the contracting parties are not both present and the woman

becomes the legal wife of the man, leaves Japan with her passport made out as Mrs., and arrives here the wife of a domiciled alien. Six thousand and three have so arrived at San Francisco in the last ten years.

CHINESE ADMITTED

The word "exclusion" used in connection with the Chinese law doubtless leads many people into the belief that *now* there are no Chinese admitted to the United States for the first time. Such is not the case, as the following are exempt classes under the Chinese Exclusion Act, coming to the United States for the first time on passports or other means of identification:

1. Officials (including Presidents of any of the "Six Companies," made ex-officio members of the Consulate in order to be admitted.) Wives, children (natural or adopted) and servants of officials, born in any foreign country whatsoever. There are no restrictions on the official class other than the passport requirement.

2. Merchants, their wives and their children, whether natural or adopted. (Merchants may return to the United States without a new passport after spending a year in the United States as merchants on testimony of two credible witnesses other than Chinese.)

3. Travelers and their families. (After completing their travels they may remain in the United States by becoming merchants or teachers.)

4. Teachers and their families. Teachers may return to the United States on same conditions as merchants.

5. Students. These may return to the United States on the same conditions as merchants or teachers.

6. While no Chinese laborers have been allowed to come to the United States for the first time since November, 1882, nevertheless those who were in this country on that date, or who had been here and came back within ninety days of that date, were allowed to go to China and return at will up to the time of passage of the Geary Act in 1893, and since then have been allowed to go and return provided they fulfilled the requirements of registration according to law, had property worth $1,000 in the United States, or debts owed to them aggregating that amount, or had a family, and provided they returned within one year, generally speaking, or within two years if circumstances entirely beyond their control had arisen and thereby legitimately detained them.

It will be readily appreciated that with these six classes of Chinese allowed to enter the United States, the total annual Chinese immigration is of considerable volume.

Chinese immigration to this country began in 1848 when the brig "Eagle" brought two men and one woman from Hongkong—it increased rapidly but irregularly; and in a speech delivered before the United States Senate on March 7, 1878, the Hon. A. A. Sargeant estimated that, up to October, 1876, 233,136 Chinese had come to the United States and that 93,273 had departed therefrom, leaving a total of 139,863 in the country on that date.

The restrictions of the exclusion law, the departure for China and other places and the natural mortality have very greatly reduced the number of domiciled Chinese until at the present date there are probably not more than 100,000 in our country.

The exclusion law does not exclude with such inflexibility that at the present time there is no Chinese immigration as a glance at the following table showing the arrivals for the last ten years will prove.

CHINESE, including alleged citizens, landed at San Francisco alone, during the years specified. (Fiscal year ending June 30, 1915.)

Year	Male	Female	Total
1905	1,701	67	1,768
1906	1,741	102	1,843
1907	2,047	99	2,146
1908	2,889	165	3,054
1909	4,294	278	4,572
1910	3,700	252	3,952
1911	2,787	189	2,976
1912	3,130	172	3,302
1913	3,145	239	3,384
1914	3,404	206	3,610
1915	3,694	242	3,936
	32,532	2,011	34,543
JAPANESE:			
1915	2,788	2,113	4,901

It was previously stated that second and third cabin aliens from Oriental ports were brought from the ships upon which they arrive to Angel Island where in conjunction with the immigration examination, the medical examination is proceeded with. The aliens are taken to the hospital and, the sexes being separated, lined up under charge of a male or female nurse as the case may be and the eyelids of every one turned by the Medical Officer conducting the examination and the conjunctiva thoroughly inspected to determine the possible presence of trachoma, which is one of the mandatorily excludable diseases. In the case of the women the medical officer makes, coupled with the eye examination, a minute inspection of the face, hands and general appearance. The slightest suspicion of any untoward condition, such as a lung or heart involvement, a skin eruption, evidence of temperature, etc., etc., is followed by a sufficiently extensive examination appropriate to the condition to determine the diagnosis; but in the absence of any suspicious signs this concludes the physical examination. The men are all stripped to the waist, the eyelids are turned and the heart and lungs tested; at the same time notice is being taken of any skin eruption, scars, deformities, or any departure from the normal, including pronounced poor physique. If any of these conditions are observed the alien is held in the hospital a sufficient length of time to obtain a proper clinical history and to arrive at some conclusion as to the underlying cause of the condition. At the conclusion of these procedures each man is taken individually behind a ward screen and completely stripped, in order that any existing abnormality below the waist may be observed. During these examinations the possible presence of tropical disease of any kind is particularly borne in mind, and it is at this time that we detect such of those tropical conditions as obtain and which do not require the use of the microscope to establish a diagnosis, or hold for later laboratory investigation persons presenting symptoms of any disease in which the specific organism is known, this latter step being necessitated because officially the attitude is assumed that it is unjustifiable to certify as present a disease of specific origin until the specific organism has been isolated. These examinations having been completed and all conditions necessitating certification to the immigration officials having been noted, each alien, both male and female, is required to furnish a specimen of feces for hookworm examination. When these specimens are properly prepared they are sent to the laboratory for microscopical examination.

By pursuing the system outlined the medical officers have, during the last three years, detected and certified to the Commissioner of Immigration over 100 different diseases, certain ones running into numbers of considerable degree, as for instance approximately 3,000 cases of hookworm disease detected and cured before being allowed to land. The list includes, besides the conditions that we in this country are accustomed to meet, such diseases as beri-beri, morphinism, uncinariasis, smallpox, trachoma, clonorchiosis, balantidic dysentery, liver abscess, sprue, elephantiasis, leprosy and tropical dysentery.

It may be possible with the progress of time and the accompanying extension of travel with its broadening effect, and the probable partial obliteration of strict geographical lines, that intermarriage between Oriental and Occidental will be very much more frequent than at present. If that be the case it is reassuring to know that aliens arriving at our California ports suffering from mental, moral, or physical defects, or loathsome or dangerous contagious disease will, through the operation of the Immigration Law, and in so far as they come within that law, be denied admission to our country.

PLANT BREEDING PROBLEMS

Many Opportunities on Pacific Coast—New Varieties with Definite Characters Needed—Fundamental Work with Old Varieties Must Be Done —What Has Already Been Accomplished[1]

C. L. Lewis

Chief, Division of Horticulture, Oregon Agricultural College, Corvallis, Ore.

THE Pacific coast has become world-famous because of the excellence of its fruits and fruit products. Most varieties and types of fruits that have been tried on this coast have succeeded remarkably. In fact, in most cases they do better here than they do in their native homes, growing to unusual size, developing a high degree of color, and attaining superior quality.

Now, while this fact of the success of deciduous fruits on the Pacific coast is a source of pride and satisfaction, as well of material profit, to us, I believe that it is, on the other hand, likely to lead us to the comfortable but dangerous assumption that our fruits are good enough; that, having apples, pears, plums, etc., which meet every market requirement, we have lost sight to a very large extent of the great contributions which we might make to the field of horticulture by producing new and still better varieties.

Not only should we be thus desirous of originating fruits of ever surpassing excellence, but we should be very eager to contribute to the knowledge of genetics, that we may be of service to our co-workers in this field. Do not understand me to imply that nothing has been done in this line on the Pacific coast. Consider the many contributions of Luther Burbank; the Loganberry of Judge Logan; the famous cherries of Lewelling (such as the Republican and the Bing); the introductions of other practical breeders (the Lambert, Centennial, Deacon, Lake, Hoskins, and Vesta cherries); or the superior strawberries of the Pacific Northwest; and many other improved fruits which I will not stop to enumerate—but the man who says that we have plenty of good enough varieties of fruits and nuts at the present time, and therefore need not try for new varieties, has failed to analyze the situation carefully.

SOME IMPORTANT NEEDS

We need a walnut, for example, that is immune to the ravages of the walnut blight. We need pears which can survive the attack of the fire blight. We need cherries that are never attacked by gummosis. We need prunes, especially in the Northwest, that mature earlier, are sweeter, and, if possible, larger. We need a red apple in the spring. While it is true that we have the Winesap, it is nevertheless a fact that the Winesap is very exacting in its requirements and is restricted to a rather limited area. We need an apple of wide adaptability, such as the Ben Davis, but having at the same time the qualities of the Esopus (Spitzenberg) or the Winesap, and this apple to be in its prime for the late winter or early spring market. We need cherries which escape the rainy season. Especially do we need a flesh-colored cherry of better shipping quality than is possessed by any variety we have at the present time. These are only a few of the suggestions that could be made for the practical plant breeder.

The men who are working in the field of genetics on the Pacific coast at the present time can be divided into two great classes. The first class may be called that of the plant-lover, or so-

[1] Read before the twelfth annual meeting of the American Genetic Association, Berkeley Cal., August 6, 1915.

called practical professional breeder. The aim of these men is to produce some new plant by chance or otherwise. Most of the fruits or horticultural products that have been obtained so far have come very largely by accident. I refer to the work of the Lewelling brothers, Hoskins, Logan, Burbank, Father Schoener, and many others who might be mentioned. I would in no way belittle the work of these pioneers in our field. They have contributed some of the world's choicest fruits. To Burbank we owe much; he has shown us the possibility of obtaining great variation in plants by change of environment, has taught us the value of working with large numbers and has demonstrated a wonderful aptitude and ability in segregating the valuable plants from the hosts of worthless.

One cannot help feeling, however, how much better it would be if, in connection with the origin of such cherries as the Lambert and Bing, something could be known in regard to their parentage, and the tendency of these parents to produce such fruit. Such facts would make a contribution to plant breeding well worth while, as we would have laid down fundamental foundation stones for future investigators to build on.

WORK OF SCIENTISTS

The second class of workers are our experiment station workers, research men, so to speak, who fall naturally into several divisions. First, there are those men who devote their time largely to testing certain theories of evolution; to working out certain laws of heredity; men who are attacking the fundamental problems of genetics, those which deal with the very principles of the science. A goodly number of such men will be found on the Pacific coast who will be willing to devote their lives to this work.

Second, there are those men who are dealing with problems of a somewhat indirect nature, but having a close relation to the fundamental problems of genetics. I mention the pollination studies, such as have been conducted at Oregon Agricultural Experiment Station. Some of these studies have already been published in four bulletins.

The work on the cherry has been of special interest to plant breeders, since it has shown that in the Northwest, at least, the possibility of using the Napoleon (Royal Ann), the Lambert, and the Bing is somewhat restricted, as they are sterile, and are also intersterile, so that wherever cherry seedlings are produced, they will not come as the result of crosses of these three varieties, but may come from the crossing of these varieties with others of perhaps not as great commercial value. Then there is a splendid work that Shamel is doing in southern California on the bud variation studies of citrus.

A third class consists of those workers who are forced to take up some problem having for its aim a definite commercial need, but coupled with foundation studies in genetics. I refer to the work that Webber has done with the citrus fruits, cotton, etc., to the work with the pear that is being done at the Southern Oregon Experiment Station where over twenty species of *Pyrus* have been collected, and where over 1,000 varieties of pears are being tested, to note first, their resistance to the fire blight, and secondly, to work out their value as parents in producing immune or resistant varieties of pears.

Other work is being done at the Oregon Agricultural Experiment Station with apples, cherries, prunes, etc., much along the same line as that which is being done with the pears, but of course with different aims.

I have mentioned more the work of the Oregon station, since I am more familiar with the work of that station, and not so familiar with the work under way at the other stations on the Pacific coast. Undoubtedly, however, they are also taking up this work very extensively.

PROGRESS HITHERTO SLOW

Our progress in the past has been very slow; perhaps we can almost say we have done little or nothing, practically no fundamental work in genetics as far as plant breeding is concerned. We have only touched the surface.

However, progress must be slow in a problem of this nature, and we must all be patient. The promise is very great for the future. We feel that we are on the doorstep of a dawning of great things. The workers in plant breeding are holding their breath, so to speak, for they realize that the time is close at hand when very definite, startling progress will undoubtedly be made.

Let us encourage our young investigators in every way that we can. Encourage those in the field of pure science. Encourage those who are working with the problems of morphology, cytology, physiology, and biochemistry, because many of these must be worked out before very definite progress can be made on other phases of our investigations. Let us continue our many pollination studies, for they are bound to contribute much to our knowledge of genetics. We must know more of the fundamental laws of genetics, and their adaptation to the plant kingdom, and their ultimate relation to our commercial progress. In a relatively short time we should know the value for breeding purposes of our leading varieties of fruits on the Pacific coast; we should trace back their pedigree as far as possible, and know the value of any one given variety as a parent for future work.

Some of the most promising commercial varieties may prove useless as parents, and some very unpromising commercial varieties may prove very valuable as parents. I have seen one illustration of this in apples, for example. Take the seedlings of the Ben Davis. We have found in our work that, no matter whether the Ben Davis was a male or a female parent, the seedlings from this variety tend to be weak, that they are lacking in vigor and vitality. Yet the Ben Davis apple is often spoken of as a tree of wonderful vitality. My observation of this variety, however, in the Pacific Northwest, would lead me to conclude that it is not one of great vitality. It becomes decrepit at an early age, and its seedlings are certainly very unpromising. On the other hand, we have a variety which is very seldom heard of, the White Winter Pearmain, for example. This variety when used as a parent produces vigor. It gives vegetative strength, and strong sturdy seedlings result whenever this variety is used as a parent. I simply cite these two cases to show that the field is large, that we have more work than all of us put together can do in many generations to come.

The field is measureless, the opportunity unlimited. Optimism should be the watchword of our young workers. Let the Pacific coast not only contribute to horticulture by growing to unexcelled excellence the well-known varieties of fruits, but let us contribute just as generously with new gifts of flower, fruit and vegetable, and at the same time do our share in contributing to the world's knowledge of genetics.

Grape Breeding

The first plant-breeding work in the horticultural department of the New York Agricultural Experiment Station (Geneva) was done with grapes. "The main problems with this fruit are as follows: Inheritance of color—a special effort is being made to find varieties which are pure for the various colors; inheritance of size and shape of bunch and berry; high quality; season of ripening; stamen type and its corrolary problem of self-sterility and inheritance of sex. A large number of European grapes, *Vitis vinifera*, are being grown in an attempt to find varieties adapted to this region and to use in crossing with our native species. The grape material now on the grounds comprises two vineyards of about 350 named native varieties, about fifty varieties of *Vitis vinifera*, some 800 crosses now in bearing, about 1,600 self seedlings of known varieties now in bearing and about 3,500 crosses still to fruit."

PROTECTING POLLINATED BLOSSOMS

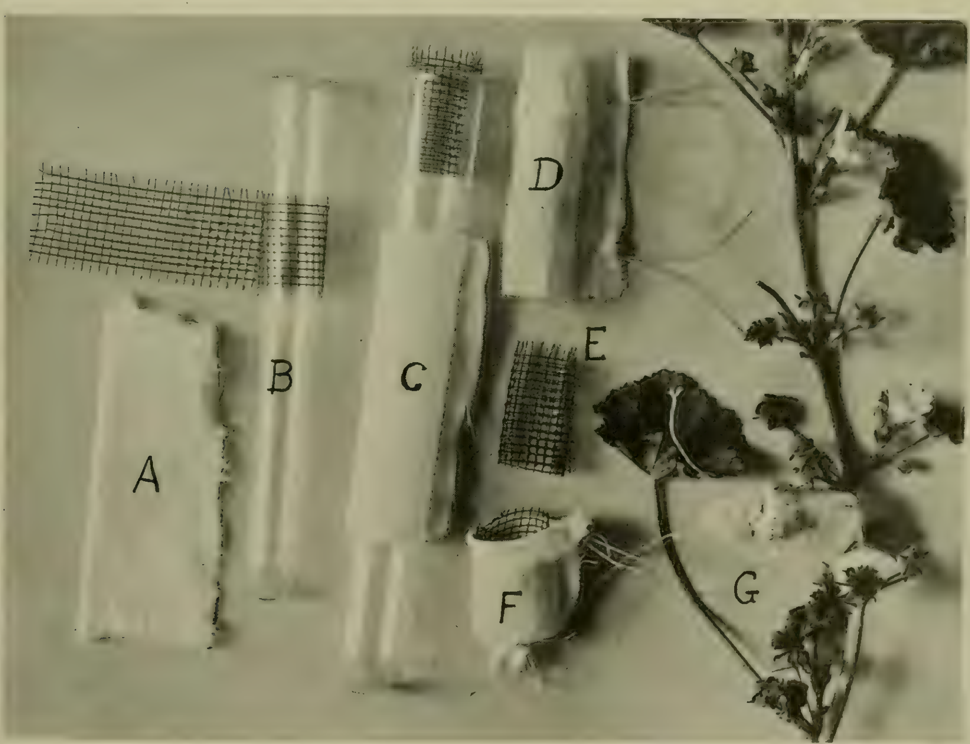
Dr. William S. Chafin, *Vanderbilt, Mich.*

IN cross-pollinating flowers, it is often necessary for the plant breeder to visit a blossom twice: the first time to remove the pollen from the flower, so it will have no opportunity to pollinate itself, and a second time when the stigmas are in a receptive condition, to apply the pollen from some other plant which he has selected as the male parent of the hybrid.

Between these two visits, it is of the utmost importance that foreign pollen, which might be carried by the wind or insects, be excluded—otherwise the results of the experiment will be thrown into confusion. It is also necessary, in most cases, to protect the pollinated flower for some time after the cross has been effected, for the same reason. Both these objects are usually accomplished by enclosing the flower in a cloth or paper sac, which of course must be removed when the flower is pollinated.

Removing these sacs and replacing them without injuring delicate flowers is sometimes a little difficult. A device which I have found very convenient because of the ease with which it may be opened or closed for this purpose and held in the fingers without danger of injuring the flower is seen in Fig. 9.

A strip of fine muslin of the proper width (a tag end of which is shown at A) is folded lengthwise, stitched along



CONVENIENT BAG FOR PROTECTING POLLINATED FLOWERS

It is distended by a frame of wire netting, which allows it to be put on or taken off the flower with little danger of injury to even the most delicate blossom. The use of a test-tube, as described in the text and shown at *E* above, allows the cloth to be slipped over the screen without any trouble from catching ends of the wire. (Fig. 9.)

the edges and cut into pieces long enough to fasten easily over the ends of a wire frame (E). This is formed, as seen at (B), by bending a strip of wire netting around a test tube and turning back the ends of the long wires to hold the frame together. The frame is now cut off and inserted in the muslin tube by means of a somewhat larger test tube (C). A piece of fine copper wire at each end completes the whole. (D).

To use, one end of the cloth is turned back over the frame like a cuff (F). It is then slipped over the flower and the cloth fastened about the stem with a few twists of wire as at (G). The frame may then be readily opened to inspect or pollinate the flower by simply untwisting the upper wire and turning back the cloth.

Light cardboard may be substituted for the wire netting, but is not as good in case of rain. The size of the frame should be varied, of course, to suit the case. Where the flowers are small and gathered at the end of a stem it is better to use a large sac and enclose the whole cluster.

No positive claim is made for originality as the device is one which might occur to anybody and doubtless has been used by others.

Plant Breeding in Minnesota

More than 300,000 plants a year are handled by the breeders of the Minnesota Agricultural Experiment Station, mostly with the object of increasing yield or hardiness. In alfalfa, the object is to produce better seed-bearing strains. Sugar beets are crossed with mangels to produce a good stock beet. Commercial varieties of grape have been carefully studied, some being found to be self-sterile and some self-fertile. In the self-sterile forms, the generative nucleus becomes degenerated, which prevents the further functioning of the pollen grain. This is believed to be the first time that the actual cause of self-sterility in grapes has been determined; obviously no cultural expedients can possibly overcome such a trouble, and the only remedy is the use of proper varieties. It will be recalled that the native American grapes, as a class, seem to be practically monoecious in nature. Although bearing vines produce male as well as female flowers, their female flowers are usually incapable of pollination from male flowers on the same vine, and depend on cross-pollination from vines that bear exclusively male flowers and—of course—no fruit. Such is the condition among the wild vines; but in the commercial varieties which have been created from them this habit has been modified, until in many cases a bearing vine produces good pollen for its own female flowers, and the planting of distinct male vines is unnecessary. Evidently, however, this habit is not well enough fixed to be wholly dependable, and is better fixed in some varieties than others. The scientific grape grower, then, will ascertain before planting just how the varieties he has picked out will behave when self-pollinated, and if they do not take kindly to this artificial means of fecundation, he will plant out enough male vines to insure a crop. Similar work has been done with the plum and strawberry. Statistical studies of the characters of many fruits are being made.

Why Do Apples Bloom Late?

The main breeding problem at the Virginia Agricultural Experiment Station is with apples, and the investigators are making a determined effort to find whether the late blooming attribute is a hereditary quality transmitted by definite discoverable laws. In addition there are genetic studies of color inheritance in lupins, phlox and other ornamentals, and a study of the possible inheritance of disease in the tomato.

UNIT CHARACTERS

Reality of Their Existence is Fundamental to Study of Evolution, But Has Never Been Proved—Independent Variability of Parts and Independent Transmissibility of Variations Open to Question[1]

S. J. Holmes

Associate Professor of Zoology, University of California, Berkeley, Cal.

THE doctrine of unit characters is one that has figured largely in speculations on heredity and evolution from the time of Darwin to the present. According to this doctrine an organism is a sort of mosaic of parts each of which is dependent for its development upon some kind of discrete entity in the germ cell. The germ cell is therefore considered a complex of organic units more or less independent of one another in their activities and transmission.

The unit character hypothesis is founded on (1) the assumed independent variability of the parts of an organism, and (2) the assumption that characters are capable of independent transmission. Independent variability was appealed to by Darwin in support of his hypothetical gemmules, by De Vries in his Intracellular Pangenesis, and especially by Weismann who has adduced a formidable array of facts in support of this doctrine upon which he founds much of his argument for the complex organization of the germ plasm.

"There are human families," says Weismann, "in which individuals occur repeatedly, and through several generations, who have a white lock of hair, in a particular spot, on an otherwise dark-haired head. This cannot be referred to external influences, it must depend on a difference in the germ, on one, too, which does not affect the whole body, not even all the hairs of the body, but only those of a particular spot on the surface of the head. It is a matter of indifference whether the white coloring of the hair-tuft is produced by an abnormal constitution of the matrix of the hair, or by other histological elements of the skin, as of the blood-vessels or nerves. It can only depend ultimately on a divergently constituted part of the germplasm, which can only affect this one spot on the head, and alter it, if it is itself different from what is usual. On this account I call *it* the *determinant* of the relevant skin-spot and hair-group."

"There must be as many of these (determinants) as there are regions in the fully-formed organism capable of independent and transmissible variation, including all the stages of development."

Weismann has no quarrel with epigenesis[2] as a theoretic possibility. The complexity of the germ plasm is to be measured by the amount of independent variability occuring in the parts of the organism. How great this amount is, how many parts are capable of undergoing heritable changes independently of the others is a question to be answered only through extensive observation, but one nevertheless capable, at least theoretically, of being answered.

WEISMANN'S ARGUMENT

Weismann argues with great plausibility that the number of independently

[1] Read before a joint meeting of the zoological section, American Association for the Advancement of Science, and the American Genetic Association, at Stanford University, August 4, 1915.

[2] Older naturalists imagined that a minute but complete embryo must be preformed and incased in either the egg or the sperm. In 1759 C. F. Wolff enunciated the doctrine of epigenesis which, modified by later discoveries, is still accepted by the world of science. As at present understood, it declares that there is no pre-existence of an organism as such, but that the embryo is a new thing created as the result of the union of egg and sperm cells.—The Editor.

heritable variations presented by organisms must be great, because it would be impossible to have complex organs evolving simultaneously, as they obviously have done, unless the improvements in the one did not modify or interfere with improvements in the others. If every variation making toward the perfection of the eye were tied up with a variation in the ear, the organs of digestion, and the structure of the limbs, it seems inevitable that there would be so much interference with one another's progress that any progressive evolution of a number of complex organ systems would be practically impossible. Variations accumulating toward the perfection of any one organ, argues Weismann, would in all probability, work toward the undoing of various other organs. Independent variability of parts must, therefore be assumed in order to make the evolution of a complex organization possible through variation and natural selection.

There is much apparent force in this argument for the conception of the organism as a mosaic product. Its real weight is difficult to estimate, plausible as it may appear, because we know so little of the possibilities of organismal variability. However the assumption of any particular kind of variability may increase or lighten the task of explaining how evolution takes place, it is obviously our first duty to inquire whether or not organisms actually vary in the way alleged. Since so much has been built upon the doctrine of independent variability of parts, the the burden of proof may fairly be held to rest with those who espouse this theory.

Let us therefore consider some of the alleged instances of independent variation. Take the classical case cited by Weismann, of the small pit in the ear which ran through several successive generations. As this is an inherited character, the germ plasm of the person transmitting it must be slightly different from that of a person without this defect. But does it follow that "it can only depend ultimately on a divergently constituted part of the germplasm, which can only affect this one spot on the head, and alter it, if it is itself different from what is usual?"

If variations such as this could come and go, leaving the rest of the organism unmodified, we should be logically led, I believe, to adopt Weismann's conclusion that these variations depend on independent carriers of some sort in the germplasm. Weismann's reasoning is good, so far as his doctrine of determinants goes, if we grant his fundamental assumption. If a small pit in the ear were absolutely the sole hereditary difference between two human beings we might be forced to consider it as a unit character depending on a special determinant, determiner, or other germinal unit or entity. But do we know that the facts are as Weismann assumes?

STUDIES NOT DEEP ENOUGH

I am quite sure that these people with a pit in the ear have never been very critically studied to find whether or not this small character may not be a mere expression of more general differences in constitution. It might very well be that this pit is simply a relatively obvious manifestation of a very slight difference which affects the organism as a whole. The same may be true of the white lock of hair and numerous other characters which appear to vary independently of the rest of the body.

The now neglected study of correlated variability has revealed numerous cases in which what appear as single variations have far-reaching connections. Supernumerary horns in sheep are said by Youatt to go along with great "length and coarseness of the fleece." In mammals in general there is a strong tendency for variation to affect simultaneously hair, teeth and hoofs or claws. Darwin points out that the white star in the forehead of horses is generally correlated with white feet, and that in "white rabbits and cattle, dark marks often co-exist on the tips of the ears and on the feet." Polydactylism, as is well known, tends to affect both hands and feet. How are we to interpret these correlations? If hands and feet vary together do the intervening parts of the skeleton re-

main unaffected? If tip of ears and hind feet show parallel variations in color does it not suggest that we are here dealing with a sort of outcropping of a color variation which is really present, but less conspicuously expressed in other parts of the skin? That bodily changes of a general nature may manifest themselves to ordinary observation in one or at least a very few characteristics is clearly shown in the effects of many diseases. Infectious diseases may have their characteristic symptoms in certain form-changes while leaving the rest of the body apparently unaffected. Hutchinson's teeth[3] in children for instance are the index of a general bodily disease which may have no other very obvious sign.

Introduce some toxin of disease into the body and you produce certain specific characters. Introduce a change affecting all the cells and certain parts only will reveal the fact by noticeable modifications. The appearance of independent variability of parts may thus result from variations that are in reality organismal in their extent. Not only have so-called particular variations not been studied sufficiently to establish the fact that they are really independent, but numerous cases are known in which variations which to casual observations would seem to affect but a single part, are nevertheless correlated with minor changes of wide extent. We contend therefore that the alleged independent variability of parts upon which Darwin, De Vries, Weismann and others have based so much of their argument for the existence of discrete germinal units rests upon an insecure foundation.

INDEPENDENT TRANSMISSION

The question of the independent transmission of characters may be dealt with more briefly. Owing to the independent way in which so-called characters such as tallness and dwarfness, flower color, characters of seed coat and various other parts of peas may be separated and combined almost at will according to the fancy of the breeder it has become customary to look upon these characters as discrete entities borne by discrete elements in the germ cells, and to consider the organism as a mosaic of independently heritable parts. From this viewpoint organisms may be likened to brick buildings in which the bricks may be taken out and replaced by others without materially affecting, except secondarily, the bricks which make up the rest of the structure. But although the facts of Mendelian inheritance are usually interpreted according to the mosaic conception, they do not I believe necessitate the adoption of this standpoint. When the *Anlage*[4] of a green pea is separated from that of a yellow one we are not compelled to assume that something in the germ cell that stands for just greenness is separated from something that is the representative of mere yellowness. We need assume only that what are separated are the *Anlagen* of organisms as wholes possessing the characteristics in question. In other words green and yellow represent organismal variations; expressed in Weismannian terms, green and yellow depend not on determinants, but upon ids, the hereditary bases of whole organisms.

The logical consequence of this standpoint we have presented is that all Mendelian characters are really general and constitutional, however they may appear to be limited to a particular feature of the organism. Many Mendelian characters are quite patently constitutional while others are apparently very limited in their extent like pea and rose comb in poultry. Attention has been so taken up with characters *per se* that I doubt if much careful scrutiny has been given to the possible correlations of characters in other parts of the body. Has anyone for instance very carefully looked for any more general attributes which may be associated with pea or rose comb, or with the smooth and wrinkled coats of peas? Correlations may be difficult to detect, not only for the reasons previously mentioned, but because the

[3] Hutchinson's teeth are a form of incisor teeth indicative of hereditary syphilis.

[4] Anlage is a German term much used by genetists to denote the hypothetical something in the germ-cells which determines the nature of a given part of the adult organism.—THE EDITOR.

associated characters may not improbably have different relations of dominance or recessiveness from that of their more obvious correlates. The question which we have raised can, at least theoretically, be decided by observation and experiment. However it is decided will make little practical difference with most of the problems that confront the investigator in genetics. But there are certain problems of genetics, I suspect, in regard to which it will be found to have an important bearing, although its chief importance is in the way it influences our views on certain fundamental problems of ontogeny and evolution. I can here indicate but a few cases in point:

BEARING ON EVOLUTION

Since I have come to see more clearly the implications of the question I have discussed, I have been surprised to find how many of the difficulties urged against the theory of natural selection disappear when we consider variations as organismal instead of limited primarily to particular parts. Most discussions, I find, consider evolutionary problems from the standpoint of the doctrine of unit characters. How common it is to find speculations as to how this or the other character could have been developed through natural selection, as if each part were somehow separately improved by a series of fortunate survivals. If each character is considered as the summation of a series of variations which primarily concern that character alone, and if the nature of the variations that are integrated is determined by natural selection, we should expect most attributes of an organism to be of a useful kind. If, on the other hand, variations of any one part involve variations throughout the organism, then the preservation of favorable variations in any one organ would of necessity entail changes in other organs which for the most part would probably have no relation to utility. On this view a considerable ingredient of non-adoptive characters would naturally be expected, and it is probable that, through correlation, parts might be evolved to a considerable degree of complexity without having any important use in the life of the organism, provided they did not become positively dangerous to their possessors. Much of the evidence adduced for orthogenesis is what we should expect to find if evolution occurred through the selection of organismal variations. Much of the difficulty about the beginnings of structures and their development up to the point where they acquire selective value would, I believe, also be removed. The wonder is not so much that selection should produce a large amount of what Haeckel would call dysteleological structures, but that it is able to produce (if we grant that it does produce) so much that is so nicely coadapted, and especially that it is able to carry on the simultaneous elaboration and perfection of numerous separate systems of organs.

In these days of attack upon evolutionary problems through direct observation and experiment, I hope I may be pardoned for presenting anything so atavistic as an academic discussion of the method of evolution. But even with our present accumulation of facts bearing on this much discussed problem there is still something to be gained by reflection, and if our reflection suggests new things to look for it will assuredly not be in vain.

How to Make a Eugenical Family Study.

Detailed suggestions to genealogists and others who want to study their ancestry, are contained in Bulletin No. 13 of the Eugenics Record Office, Cold Spring Harbor, Long Island, N. Y., which has just been issued under the title, "How to Make a Eugenical Family Study," and which will be sent to serious inquirers, upon request. It explains and fully illustrates the proper procedure, and also points out at some length the value of a knowledge of the eugenic quality of one's ancestry. Many people have been deterred from studying their family trees biologically, because they did not know how to begin; this bulletin will prove of great help to them.

ILLUSTRATION OF INBREEDING

Maize Self-Pollinated for Three Generations Produces One-fourth Albino Plants —Abnormality Isolated and Bred Out of Part of the Stock

D. F. Jones

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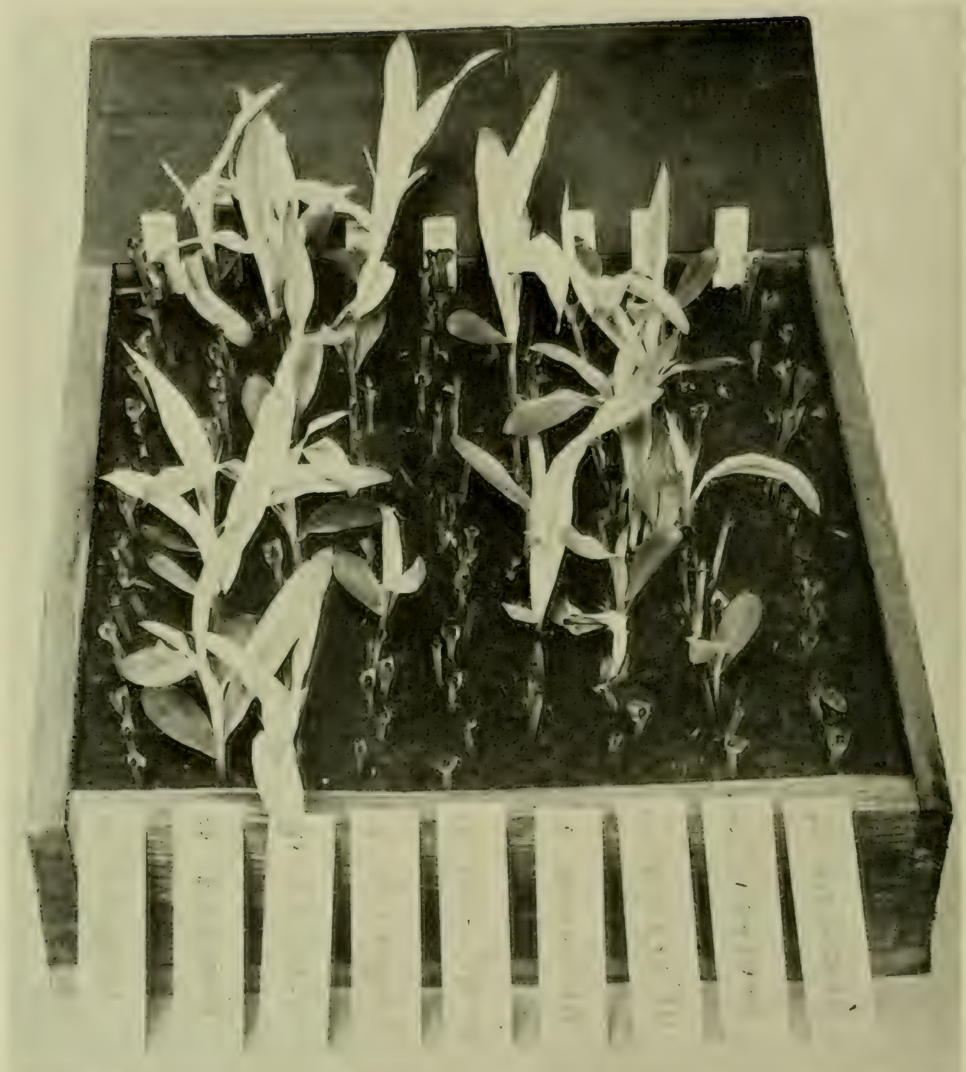
THE noticeable results attending systematic inbreeding of a cross-bred race of plants are the reduction of vegetative vigor and the isolation of abnormalities. The prejudice against inbreeding is largely due to this latter effect. Inbreeding, however, is the quickest way to make abnormal tendencies visible so that they can be eliminated.

The way in which an abnormality is brought to light by inbreeding is illustrated by a race of Leaming corn which had been self-pollinated for three generations. Two rows of this race in our corn plot this spring produced so many albino seedlings that it was impossible to secure a good stand of plants although an excess of seed was planted.

Albino seedlings in corn are common. Few fields are without a small number of them, but the percentage is so low as to be of no practical effect. Since chlorophyll reduction or albinism in

ALBINO AND NORMAL MAIZE PLANTS

Most fields of Indian corn contain a few albino plants, which lack altogether the chlorophyll or green coloring matter that every plant normally possesses. When a race of plants is inbred, one effect is to accentuate any abnormalities present. Consequently when a race of corn was inbred for three generations, it was natural to expect that the proportion of albinism would be much increased. This photograph shows a hill of Leaming corn grown from seed which had been inbred three generations: it contains three albinos and two normal green plants. (Fig. 10.)



THE PROPORTION OF ALBINOS

There were on hand nine ears representing as many different plants of the inbred maize, and thirty seeds from each ear were planted in a row in a flat, as shown above. Mathematical calculations based on the laws of heredity showed that one-third of these ears should lack the factor for albinism, and produce nothing but green plants; the other two-thirds of the ears should produce one albino plant for every three green plants. The photograph shows the flat with the green plants all cut out: it is observable that one-third of the rows (Nos. 1, 5, 9), as was expected, produced no albinos whatever, while the percentage of albinos in the other rows conformed as closely to expectation as is usual when such small numbers are involved. Row No. 1 was cross-pollinated, as noted in the text. (Fig. 11.)

corn and other plants has been shown to be a simple recessive character,[1] then in an inbred race one-fourth of the plants must be albinos if they occur at all. This large percentage of white plants is quite noticeable in the field.

The numbers secured in this case agree with other published results.[2] The two rows in the field representing two ears from the same inbred race gave 72 white and 232 normal green plants.

There were on hand nine ears, representing nine different plants of this inbred lot which were grown in 1914 from a hand-pollinated, selfed plant in 1913. Two-thirds of these ears should be heterozygous for the abnormality and give albino plants in a three to one ratio. One-third of the ears should give only green plants. About thirty seeds from each ear were planted in a flat. Eight of these nine ears were hand pollinated and selfed. Ear No. 1 was not selfed, but pollinated with a brother plant. The chances that it would show albinos were four out of nine instead of two out of three. It produced only green plants. Of the other eight ears, numbers 5 and 9 gave only green plants as shown in Fig. 11. The remaining six ears gave albino plants as follows:

Number.	Ear Number.	White Plants.	Green Plants.
2	(14-10) 4-6-3	5	19
3	(14-10) 4-6-4	9	13
4	(14-10) 4-6-16	4	21
6	(14-10) 4-6-13	4	15
7	(14-10) 4-6-2	8	15
8	(14-10) 4-6-11	4	25
Total		34	108
Theoretical		35	105

Seed from the original ear of the parent plant, (14-10) 4-6, grown in 1913 which produced the above ears in 1914 gave five albinos out of thirty-five plants grown.

No seed is available of previous generations and no record was made of albino plants occurring in this strain but it is probable that they have occurred each year. It seems safe to say that two of these strains, numbers five and nine, are now free from this abnormality.

[1] Emerson, R. A. "The Inheritance of Certain Forms of Chlorophyll Reduction in Corn Leaves." Nebr. Agr. Expt. Station, Twenty-fifth Annual Report, 1912. See also Miles, F. C., "A Genetic and Cytological Study of Certain Types of Albinism in Maize." Journal of Genetics, January, 1915.

[2] See Emerson and Miles, *loc. cit.*

Production of New Cereals

Grains are systematically bred at the Washington State Experiment Station. With wind and insect pollinated plants, such as maize, rye and the grain sorghums, straight selection is much employed, but with self-pollinated grains such as wheat, oats and barley, hybridization is more used. No selection is made until the second generation, at which time all apparently desirable plants are picked out and planted in triplicate for further tests. The basis for such tests with small grains is the rod row, 150 seeds per row and the rows 18 inches apart. Maize is planted in duplicate rows thirty-six hills long and three stalks per hill. After such a test, the value of any new sort can be determined with a good deal of accuracy.

Plant Breeding in Alabama

Hybridization in cotton and oats has been the principal plant-breeding work of the Alabama Agricultural Experiment Station. Studies of correlation in cotton, conducted under the Adams' Fund, have been in progress for nine years. Studies in correlation are also being made in maize.

REVERSION IN SHEEP

L. L. Heller

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THOSE familiar with sheep know that the Rambouillet breed, a French improvement on the Spanish Merino, is one of the most highly improved of all sheep. Its color is pure white.

On April 4, 1915, there were dropped in the United States Department of Agriculture experiment flock at Laramie, Wyo., twin ewe Rambouillet lambs. The one was an ordinary lamb in all respects; the other was marked as the accompanying photograph shows—the ventral part of the body, the legs, the lower part of the neck, the face with the exception of a bar between the eyes, and the inside of the ears being black.

The fine-wools have been improved as long and probably breed as true as any of the existing breeds of sheep. Yet this is not the first appearance among them of the pattern here noted. Markings very similar to these have also been seen in black sheep of other breeds. If this color pattern had occurred but once it would have no special significance and could be considered a mutation or sport, but occurring a number of times as it has it suggests the possibility of reversion to the markings of some original forebear, who existed perhaps thousands of years ago.

The markings of the Barbados or woolless sheep are sometimes after this same pattern, and it has been noted in crosses of the Southdown and Barbados too. The Barbados being an unimproved sheep having coarse brown and black hair with a small amount of wool beneath, makes the question pertinent as to whether our improved breeds could have come from a similar type, and whether this character has for the most part been latent during the past several centuries and cropped out only at intervals.

WHITE LAMB'S TWIN

The occasional appearance of this color pattern in highly improved breeds indicates that it may represent the markings of the ancestor of modern domesticated sheep. (Fig. 12.)

The

Journal of Heredity

(Formerly the American Breeders' Magazine)

Vol. VI, No. 11 November, 1915

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The Journal of Heredity is published monthly by the American Genetic Association (formerly called the American Breeders' Association) for the benefit of its members. Canadian members who desire to receive it should send 25 cents a year, in addition to their regular membership dues of $2, because of additional postage on the magazine; foreign members pay 50 cents extra for the same reason. Subscription price to non-members, $2.00 a year, foreign postage extra; price of single copies, 25 cents.

Entered as second-class matter February 24, 1915, at the postoffice at Washington, D. C., under the act of August 24, 1912.

Date of issue of this number, October 25, 1915.

A HEN THAT CROWED

This Buff Orpington hen, hatched at the Bureau of Animal Industry experimental farm, Beltsville, Md., began to lay on November 16 of that year and was trap-nested until November, 1914. In that period she laid 110 eggs, the last one on August 3, 1914, at which time she began to moult. Following the moult she began to develop the secondary sexual characters of the male; the tail feathers changed in appearance, the comb increased in size, the head came to look more like that of a cock, and the legs took on the redness characteristic of the male Buff Orpington. She was observed to crow several times; she occasionally visited the nest but never laid an egg. The above photograph from the U. S. Department of Agriculture was taken not long before she was killed, August 26, 1915, as the result of a general break-down of her health. Dissection showed no evidence of any development of male reproductive organs, but disclosed a large tumor on the ovary. It is a good hypothesis that this growth, by inhibiting the secretions connected with femaleness, had allowed the male characters to become apparent; for there is reason to believe that every fowl has the potential ability to develop the characters of either sex. (Frontispiece.)

POULTRY BREEDING

Experimental Work of Genetists During Last Fifteen Years Has Shown Mode of Inheritance of Many Characters, but Has Not Materially Modified Practical Methods of Commercial Breeders[1]

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IT IS not the intention in this paper to enter into a detailed discussion of the experimental work which has been carried on in breeding poultry in the last twenty-five years or to discuss the methods used, but simply to summarize briefly the results obtained and to comment on the possible or probable value of these results in practical poultry breeding. While the behavior of the characters of domestic poultry in inheritance, no matter what their nature, is undoubtedly a study of great scientific value and of general biological interest, it is nevertheless true that only so far as it has a bearing or a possible bearing on the practical problems of poultry breeding is it of interest to the great mass of poultry keepers and others vitally concerned with the vast poultry industry. It is this latter phase which is of paramount interest to the writer.

Domestic poultry as a subject for experimental breeding has much to commend it and has in consequence been one of the most popular classes of animals for this purpose. Not only are chickens widely diversified as to form and color, but in respect to many other characteristics, such as comb, number of toes, shank color, shank feathering, etc., the difference is great and the contrast sharp. Their comparatively small size with the resulting feasibility of keeping a large number at a relatively small cost is also a factor greatly in their favor. But perhaps the considerations which make chickens especially desirable for this class of work are the short time necessary to bring them to maturity, making it possible to secure a new generation each year, the relatively high fecundity, making it possible to secure a large number of offspring from a single mating, and the readiness of the fowls to breed at any season of the year.

BATESON'S PIONEER WORK

Following the rediscovery of Mendel's Law in 1900, there was begun and has since been carried on a considerable amount of experimental breeding of poultry. The first work along this line was that of William Bateson and others as detailed in the reports to the Evolution Committee of the Royal Society of London. Since then many others have taken up work of a similar nature. In this country, the Carnegie Institution's Department of Experimental Evolution at Cold Spring Harbor, Long Island, N. Y., under the direction of C. B. Davenport, has been especially active along these lines. Practically all of the breeding has been cross-breeding with the object of testing the behavior of characters of the individuals crossed to see whether they behaved in accordance with Mendel's Law. Theory and results have on the whole been in fairly close accord. As a result of these experiments a considerable mass of data has been secured, most of which has to do with the dominance or recessiveness of unit characters of poultry and with the limited inheritance of certain characters

[1] Address before the twelfth annual meeting of the American Genetic Association, at Berkeley, Calif., August 3, 1915.

or the repulsion between two factors resulting in what is known as sex-limited inheritance.

An explanation of what constitutes dominance or recessiveness is unnecessary and is not offered in this paper. It is only desired to show in tabular form the dominance and recessiveness of many of the common characters of poultry as they have been worked out. For this purpose it is impossible to do better than to use intact the table given by Dr. P. B. Hadley in the 1915 American Poultry Year Book.

TABLE SHOWING THE MODE OF INHERITANCE OF SOME OF THE COMMON CHARACTERS OF POULTRY

Dominant	*Recessive*	*Remarks*
Dominant white (Leghorn)	Black, red, buff	Almost complete dominance
Black, red, buff	Recessive white (Minorca)	Almost complete dominance
Black (Hamburg, Minorca)	Red, buff (Wyandotte)	Almost complete dominance
Barred plumage-pattern	Recessive white, black self-color	Sex-limited inheritance
Game pattern (Leghorn)	Recessive white (Minorca)	Sex-limited inheritance
Black self-color (Minorca)	Hackle-lacing (Brahma)	Imperfect dominance
Plain feathering	Silky feathering	Complete dominance
Frizzle feathering	Normal repent feathering	Complete dominance
Rose or pea comb	Single comb	Complete dominance
Single comb	Comblessness (Breda)	Complete dominance
Crest (Silky)	No crest	Imperfect dominance
Normal head	Cerebral hernia (Polish)	Imperfect dominance
Rumplessness	Normal uropygium	Imperfect dominance
Extra toes	Normal foot	Imperfect dominance
Joining of toes	Normal foot	Imperfect dominance
Silky pigmentation	Normal mesoderm color	Imperfect dominance*
Yellow skin color	White skin color	Complete dominance
Yellow shank color	Light shank color	Complete dominance
Dark shank color	Light shank color	Complete dominance
Black iris color	Brown, red, pearl iris	Complete dominance
Red ear-lobe	White ear-lobe	Imperfect dominance
Feathered shanks	Clean shanks	Imperfect dominance
Plain heel	Vulture hock (Silky)	Imperfect dominance
Booting (Silky)	No booting	Imperfect dominance
Beard (Houdan)	No beard	Almost complete dominance
Long tail (Japanese)	Normal tail	Imperfect dominance
Rapid feathering	Slow feathering	Almost complete dominance
Broodiness (Silky)	Non-broodiness	Almost complete dominance

* Sex-limited in Brown Leghorn and Silky crosses.

It will be noted from this table that in only a few cases is dominance listed as complete. There is a variation all the way from complete dominance to a very weak dominance and to explain this variation it has been necessary to fall back upon the idea of prepotency. It might also be well to call attention here to the case of the blue color of the Andalusian where neither of a pair of characters shows dominance over the other. The Black Andalusian and the Splashed White Andalusian bred together give all blue offspring. These blues when bred together give blacks, splashed whites and blues in the usual mendelian proportion. Here the black color and the splashed white seem to be the mendelian characters, neither of which proves to be dominant but the two exist side by side in the hybrid in a minute mosaic which causes the blue color. The blue individual is therefore always heterozygous or "mongrel."

In addition to the characters tabulated, recent studies with the "bare-neck" breed of poultry support the view that the nature of the factor which prevents feather growth on the neck is dominant.

SEX-LIMITED INHERITANCE

Certain of the characters of domestic poultry are inherited in a manner known as sex-limited. We are accustomed to observing the usual limitation of certain secondary sexual characters to their respective sexes, such as the spur and long sickle feathers of the cock, but it has remained for experimental breeding to point out that certain other characters are also sex-limited. Per-

haps the best known example of sex limited inheritance is the barred color pattern of the Barred Plymouth Rock, which seems to occur in accordance with a mendelian hypothesis developed along lines first suggested by Spillman.

The female, by this hypothesis, is considered to be heterozygous both for sex and for barring while a repulsion is assumed between the determiners for these two characters which prohibits their occurrence in the same gamete. The male is considered to be homozygous in respect to sex and either homozygous or heterozygous in respect to barring. The females, therefore, inherit barring from their sire alone. A number of different crosses have been made and reported which support this hypothesis, *e.g.*, Black Langshan and Barred Plymouth Rocks, Cornish Indian Game and Barred Rock, White Cochin and Tosa, and Barred Plymouth Rocks with Campines, with Golden Pencilled Wyandottes, with Black Hamburg, with White Wyandottes and with White Plymouth Rocks.

Sex-linkage has been reported in a number of other instances, such as an inhibiting factor influencing the mesodermal pigmentation of the Silky, Brown Leghorn color pattern, an inhibition for red in the plumage carried by the Columbian Wyandotte, the gray of the White Wyandotte and the factor on which high fecundity depends.

INHERITANCE OF EGG PRODUCTION

For about nine years, from 1898 to 1907, at the Maine Agricultural Experiment Station, a systematic breeding experiment was carried on in an effort to increase the average egg production of the Station's poultry stock. The plan of the experiment was to select breeders upon the basis of their performance alone as shown by the trap nest. It was expected that the high production would be handed down from mother to daughter and that the selection practiced would be cumulative in its effect. Indeed it was generally supposed that a substantial increase in the average egg yield had been obtained but a complete and searching analysis not only failed to reveal such an increase but actually showed a slight decrease since the beginning of the experiment.

In 1907 the plan of procedure was changed and one of the steps taken was to cross the original stock of the station, the Barred Plymouth Rock, a breed of relatively good laying ability, with the Cornish Fowl, a breed of relatively poor laying ability. A study of the inheritance of fecundity in these crossbred individuals and in other matings resulted in the hypothesis advanced by Dr. Raymond Pearl, that the factor responsible for high egg production behaved as a sex-limited character. According to this hypothesis, the female is heterozygous for sex and also for the factor for high fecundity and these two factors cannot be present in the same gamete. It follows therefore that a daughter cannot inherit high fecundity directly from her dam but must always inherit it, if present, from her sire. She may, however, inherit low fecundity from either dam or sire or from both.[2]

PRACTICAL RESULTS

The application of Mendelism to poultry breeding holds out not the slightest hope of creating new characters. It does, however, point out the way to secure new combinations of desired characters by crossing varieties or breeds possessing them and by careful breeding to fix this combination in one breed or variety. In so far as a pair of characters behave as a strictly representative Mendelian pair, one of which shows complete dominance over the other, the application of Mendelism to poultry breeding will prove an advantage in poultry work as it will often provide a short cut to the desired end by providing a quicker means of testing out the purity

[2] The conclusions of the Maine station are based on the belief that high egg production is a unit character. But the results of eight years work at the Utah station, presented by E. D. Ball and Byron Alder at the last meeting of the American Genetic Association, but not yet published, fail to confirm this conclusion. The twenty-seventh annual report of the Massachusetts Agricultural Station, summing up the studies on egg-production there, also indicates a belief that high egg production is a compound, not a simple, trait. The question probably must be considered an open one for the present.

of a bird with respect to the particular character or characters. It will also often serve as a means to prevent the beginner in poultry breeding from making mistakes.

Unfortunately, however, the dominance of one of a pair of characters over another is in most cases not complete. As a consequence, results are not sufficiently exact and clean-cut to allow the application of the principles of Mendelism with assurance and reasonable certainty. Because the character or characters do not segregate in a pure state, it becomes necessary for the breeder to adopt a system largely empirical, with the object of using in his matings those individuals or lines which show the greatest purity in this respect. In other words, he must depend very largely as a basis of selection of breeders upon the results obtained in the offspring. He is unable to predict with sufficient certainty just what the results will be. Now this is exactly the position which the practical breeder has always occupied. He must select his breeders upon the basis of their appearance, upon his knowledge of their ancestry and principally upon the results obtained from breeding them. Therefore, while the Mendelist uses as his guide in breeding, the principles of Mendel's Law and the practical breeder uses the knowledge accumulated through experience, the methods used by each to secure a desired result in actual practice are identical or nearly identical. There is little in the data so far obtained as the result of experimental breeding which will enable the practical breeder to breed with a much greater degree of certainty or which would enable him to change his operations for simpler procedure.

BREEDING FOR EGGS

Dr. Pearl in connection with his hypothesis of the method of inheritance of high fecundity, advances for the benefit of the practical poultry breeder a plan for improving the average egg production of his flock. This consists of the following steps:

(*a*) Selection of all breeding birds on the basis of constitutional vigor and vitality;

(*b*) The use as breeders of such females only as have shown themselves, by trap nest records, to be high producers;

(*c*) The use as breeders of such males only as are known to be the sons of high producing dams;

(*d*) The use of a pedigree system by which it is possible to tell the sire of any particular bird;

(*e*) The making of a large number of matings so as to use as many different male birds as possible and;

(*f*) The continued but not narrow inbreeding of those lines in which there is a preponderance of daughters which are high producers.

In connection with this plan it only remains to point out again that such a plan is identical or very nearly so with the steps which any intelligent breeder of experience would take if he attempted to make any systematic effort to better the egg production of his stock. The only point where it might differ would be in the matter of testing out the various males and breeding those lines showing the greatest promise. However, any poultryman who is sufficiently interested in his breeding to make an attempt to keep a pedigree record of his birds, or at least a pen record—and many of them do—would certainly fail in intelligent effort if he did not concentrate his breeding on those lines which showed most favorable results.

The experimental breeding of poultry has undoubtedly been of benefit to the poultry industry generally. Not only has it given us a considerable amount of information as to the manner in which characters are inherited but by arousing interest in the subject, it has caused poultrymen to give more careful thought to the problems by which they are confronted. It has also called attention to the necessity of keeping more exact pedigree records and by so doing will undoubtedly bring about much more systematic efforts which will in turn lead to greater progress.

The work which has already been reported and the interest aroused has brought about the inauguration of

work of a similar nature at many of the State Experiment Stations in the United States. The various stations have been asked to supply a brief statement of any work in poultry breeding which they may be carrying on and the replies of those stations which sent in a report and are carrying on any work of this nature are briefly summarized below:

Purdue University Experiment Station, Lafayette, Indiana.

A study of the influence of inheritance on egg production.

Kansas Experiment Station, Manhattan, Kansas.

A study of the value of standard bred males from high producing lines in grading mongrel flocks.

Maine Experiment Station, Orono, Maine.

1. Inheritance of fecundity and breeding for egg production.
2. Mendelian inheritance of various plumage and other bodily characters.
3. Inheritance of body size, egg size and color.
4. Inbreeding.
5. The effect of various external agents on the germ plasm.
6. The inheritance and determination of sex.

Massachusetts Experiment Station, Amherst, Massachusetts.

1. Breeding for egg production.
2. A study of the hatching quality of eggs from the genetic standpoint.
3. Inheritance of various external characters of poultry.

Missouri Agricultural Experiment Station, Columbia, Missouri.

A study of sex-limited inheritance of the spangled pattern of the Hamburg and the "hen-feathering" of the Sebright Bantam cocks.

New Jersey Experiment Station, New Brunswick, New Jersey.

1. Inheritance of fecundity.
2. Inheritance of various plumage characteristics and other body characters.
3. The barred factor in Single Comb White Leghorns.
4. Inheritance of shell color.

North Carolina Experiment Station, West Raleigh, North Carolina.

1. Inheritance of high egg production.
2. Inheritance of shell color of eggs.

Oregon Experiment Station, Corvallis, Oregon.

1. Inheritance of high egg laying.
2. Correlation between type and high egg laying.
3. Cross breeding.
4. The development of a special variety of chickens with high egg production and also good meat quality.

Utah Experiment Station, Logan, Utah.

1. A study of the possibility of improving egg production by continued selection.
2. A study of egg production with special reference to (*a*) average winter egg production as compared with the average yearly production covering a period of the first, second and third years of production, and (*b*) limits of seasonal variation in the average flock production.

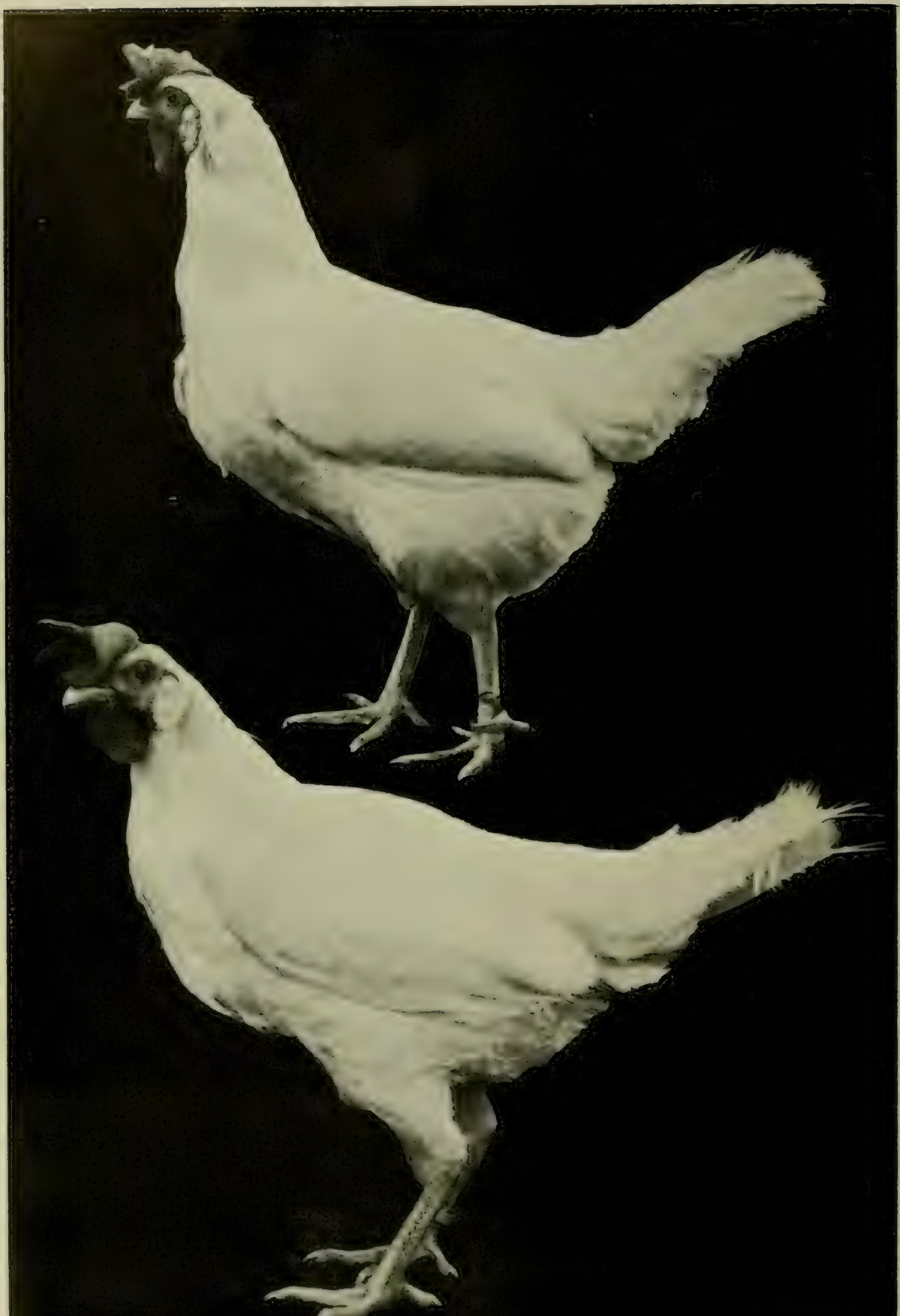
Wisconsin Experiment Station, Madison, Wisconsin.

1. Experiments on inbreeding.
2. Study of the effects of lead poison of the male upon his offspring.
3. Inheritance of plumage color and some other characters in pigeons.

Redfield's Offer Still Open

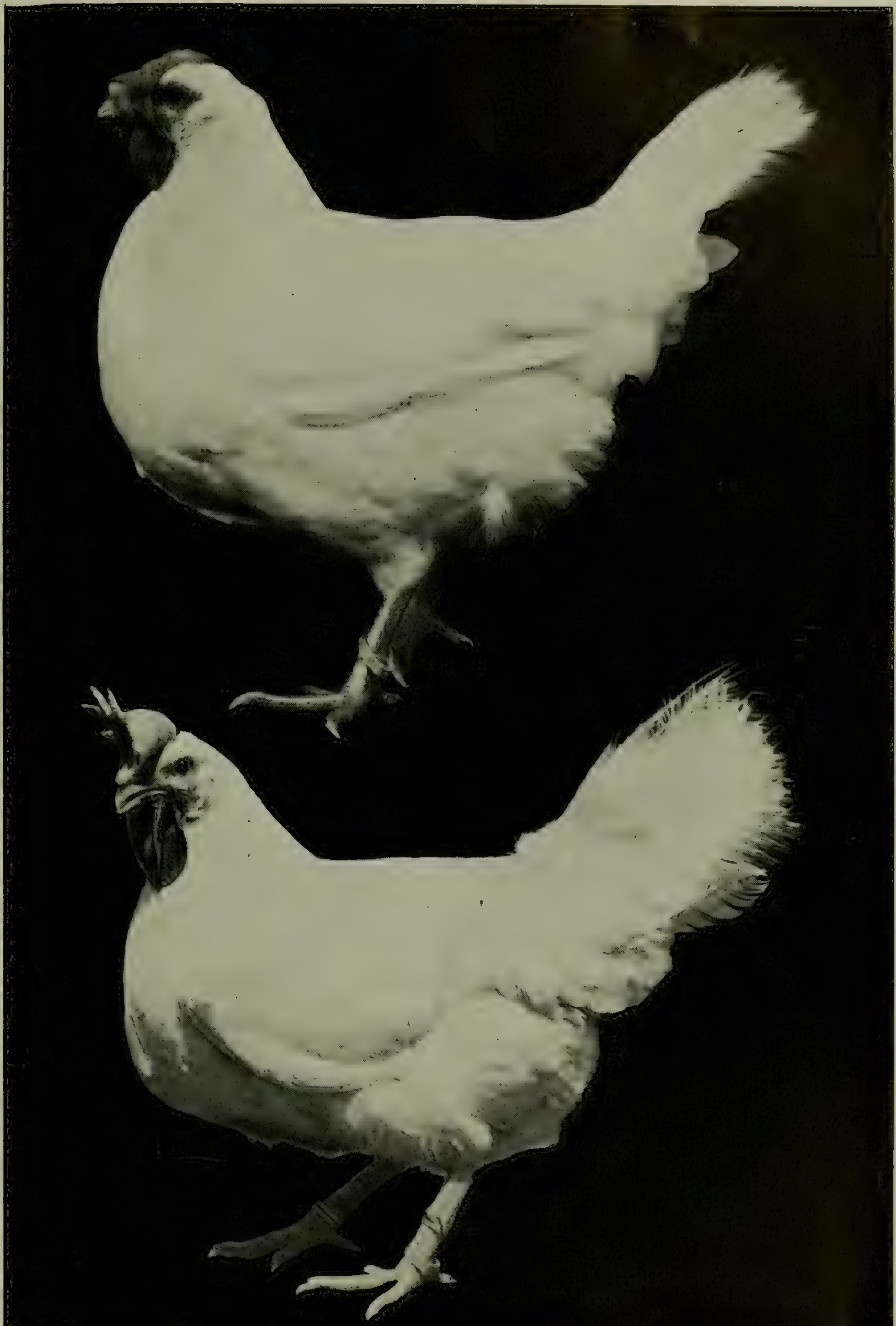
Attention is called to the fact that C. L. Redfield's offer of a reward for data regarding early marriages closes at the end of the present year, and up to date has not been productive of results. He proposes to donate $100 to this association "if it can be shown that any superior individual ever was produced by breeding human beings as rapidly as four generation in a century," or "if there can be found more than three cases in which the intellectually superior person has as many as four generations in a century in the tail-male alone." By "superior individuals" he understands "any one of the 2,000 or 3,000 intellectually eminent men known to history." Again, raising the standard to the two or three hundred great geniuses of history, he proposes to donate another $100 if a single one of them can be found in the three-generations-to-a-century class. The association will be glad to hear from genealogists who can throw light on these matters.

THESE HENS ARE PROFITABLE



In a test of White Leghorns at Hawkesbury Agricultural College, Richmond, New South Wales, 1913-1914, the hen above laid 219 eggs in twelve months, the hen below laid 288 eggs in the same length of time. The latter figure represents a record which has been equaled but never surpassed. Hens of the type here shown should be chosen by the poultryman who wants a flock that will earn its keep. Photographs from the Agricultural Gazette of N. S. W. (Fig. 1.)

THESE HENS SHOULD GO TO THE POT



In the Hawkesbury Agricultural College competition the hen shown above laid only ten eggs between April 1, 1913, and March 31, 1914. The hen below laid only twenty-three eggs in the same period. Hens of this type should not be kept in a pen intended for egg production. It is likely that their fatness shows they have kept all their nutrition for themselves, while the lean hens on the opposite page have devoted much of their nutrition to producing eggs. Photos from Agricultural Gazette. (Fig. 2.)

HOW THE BARK BREATHES

LIKE all other living things, plants must breathe or they will not continue to live. The more highly specialized among them are therefore provided with elaborate respiratory systems, consisting of passages which conduct air to all parts of the plant, and openings on the surface, through which oxygen can be taken in and carbon dioxide given out, substantially as is the case with animals.

The external openings of this ventilating system are of three general types: stomata or valves on the surfaces of leaves and young shoots;[1] ventilating pores, which occur in certain aerial roots; and lenticels, pores in the older wood, whose presence can be noted by the unaided eye in almost any plant, and which are photographed, enlarged, in Figs. 3 and 4.

The earlier naturalists were quite in the dark as to the function of these pores. Guettard, who described them in 1745, designated them merely as glands; De Candolle (1826) thought they were a kind of bud, from which roots later put forth; Unger (1838) believed they had something to do with reproduction; but as early as 1809, Dupetit-Thouars declared their purpose was ventilation, and the work of several students during the next half century demonstrated that this opinion was well founded.

Although he misunderstood their purpose, De Candolle gave them the name which they now bear, because of the resemblance of one of these pores to a minute, bi-convex lens, in general shape.

They are usually found on both stem and root of a plant, but may also appear on leaf-stems, and sometimes on fruits—the walnut and horse-chestnut, for instance.

Yet, in spite of their widespread distribution, they have been sought in vain on some plants. They appear not to exist on the European grape (*Vitis vinifera*), although they can easily be seen on its close relative, the Scuppernong grape of the southern United States (*Vitis rotundifolia*); they have been not discovered on the Italian honeysuckle, the trumpet creeper *Tecoma radicans*, some species of Clematis, the Philadelphus or mock-orange, Deutzia, *Rubus odoratus*, etc.

It has been explained that these plants are provided with a regularly repeated annular formation of the bark, and therefore do not stand in such need of lenticels for the purpose of ventilation. But this hypothesis carries little weight, when one finds that other plants with similar bark have lenticels. Why, for instance, should the climbing honeysuckles lack these organs, while those which do not climb possess them? And why are they present in the bittersweet (*Solanum dulcamara*), the Boston Ivy (Ampelopsis), the Wistaria, and other plants which have habits of growth and formation of bark similar to those above referred to, which lack lenticels?

Another difficulty in the way of believing the idea once held, that they are indispensable to the respiration of the plant, is the fact that during a considerable part of the year they are partly or wholly closed by the formation of a layer of cork underneath them. This is particularly the case in winter, the plant's resting period, when little ventilation is necessary; but observers have found that this closing of the ventilators often begins in early summer, so that spring is the only season when the lenticels are functioning.

Further, it has been discovered that the lenticels are in some cases permanently closed: they look normal from the outside, but are in reality of no value whatever to the plant for breathing.

[1] For an excellent photograph of stomata on a wheat leaf, enlarged about 300 diameters, see the Journal of Heredity, Vol. VI, No. 3, p. 125, March, 1915.

THE VENTILATORS OF A ROSE TWIG

The irregular openings or "eruptive craters" in the bark, photographed under high magnification, are known as lenticels, and serve as pores through which air is admitted to the inside of the plant. By channels and passages of various kinds between the interior cells of the plant, the air passes to even the most distant parts. The plant is thus enabled to renew its supply of oxygen, and at the same time it discharges carbon dioxide through the lenticels. (Fig. 3.)

ON A MOIST DAY

Twig of a Chinese magnolia, highly magnified. The dry, powdery cells which fill the breathing pores of the bark have absorbed moisture from the air, until they have swelled out and protrude like warts. One of the functions of the lenticels is to regulate the transpiration of moisture between the interior of the tree and the outside air. (Fig. 4.)

These facts have led many plant physiologists to think that, although the lenticels undoubtedly do fulfil in many cases the function of breathing pores for the bark, that is not really their *purpose*. Such a solution of the problem accords well with the interpretation of nature of certain scientists, who hold on philosophical grounds that nothing should be said really to have a purpose.

EXPERIMENTAL TESTS

But whether breathing is the *purpose* of the lenticel or not, one can very easily demonstrate that it actually does act in most cases as an outlet for the plant's ventilating system. A favorite laboratory experiment is to seal up one end of a stick, seal a tube around the other end, and then force air under pressure through the stick, submerged in water. A string of fine bubbles will issue from every lenticel. The fact can be demonstrated even more easily, merely by sealing both ends of a short stick and then submerging it in warm water; the warmth will in most cases be sufficient to expel the cooler air within the stick, and bubbles will appear at the lenticels.

Sometimes these openings reach a length as great as a third of an inch; in other cases, as in the bark of the sycamore (Platanus), they are so small as to be almost microscopic. In twigs they are commonest on the under side, and the number increases somewhat regularly with the age of the wood. On a piece of elm branch 20 centimeters long, Haberlandt found the number of lenticels as follows:

	First year	Third to fifth years	Tenth to fifteenth years
Upper side	55	66	95
Under side	70	78	96

The lenticels usually begin formation under the surface, frequently beneath one of the stomata, in which case, as the epidermis is gradually replaced by cork (*i. e.*, bark), the lenticels take the place of the stomata as ventilating pores.

Structurally, the lenticel may be described in simplest terms as an opening through the bark, which is filled,

in most cases, with a mass of powdery packing-cells, so loosely arranged that air can easily pass between them. In wet weather these cells usually expand and protrude from the opening, so that the lenticel comes to resemble a wart.

This response to the humidity of the outside air gives the clue to another function which the lenticels share with the stomata—to aid in regulating the transpiration of the plant. Indeed, Devaux,[2] one of the latest botanists to give the subject careful study, concludes that it is more correct to say they regulate the amount of moisture in the plant than to ascribe ventilation as their chief function.

[2] Recherches sur les Lenticelles, by H. Devaux, professor at the University of Bordeaux. Annales des Sciences Naturelles, 8ième série, Botanique; t. XII, 1900.

NEW PUBLICATIONS

MICROBES AND MEN, by Robert T. Morris, M. D. Pp. 539, price $2 net. New York, Doubleday Page & Co., 1915.

It is rather difficult to think of any social question on which this book by a distinguished New York surgeon does not touch. His aim is to show the influence of the microbe in all evolution; to demonstrate that "the microbe limits cultivation of any organism because under conditions of higher cultivation organisms become more and more susceptible to microbe influence. The logical end of culture is elimination of the race among plants and animals." But the book itself is far more readable than one would suspect from this synopsis: one can dip into it anywhere and find something to stimulate thought. Dr. Morris intimates that one of his hopes is to cause readers to disagree with him, and he will doubtless attain this end in many cases. But at least, the reader will be interested. The layman, however, should bear in mind that the author does not always make it clear whether his statements are based on fact or speculation.

JOHN AND ELIZABETH, a Romance in Real Life, by Jay Gee. Pp. 162, price 50 cents. Washington, D. C., the Volta Bureau, 1601 Thirty-fifth Street NW.

Mr. Gee frankly declares that he has written a novel with a purpose—"to show the great dangers of hereditary disease." Congenital deafness furnishes the background of a simple love story, or rather, the love story serves as a vehicle to carry a rather full discussion of congenital deafness. Novels with purposes are not new, but Mr. Gee has performed a really extraordinary feat in writing one, the scientific basis of which is perfectly sound. The book can be recommended without hesitation to anyone who wants a sugar-coated statement of modern views as to the inheritance of congenital defects.

EUGENICS AND MARRIAGE, by Lee Alexander Stone, M.D. A Primer of Social Hygiene. Reprinted from the *Journal of the Tennessee State Medical Association*, September, 1915. Pp. 64; price 25 cents; by the author, Memphis, Tenn.

EFFECT OF THE POPULAR SIRE

A Statistical Study of Three Varieties of Terriers—Over Forty Per Cent. of the Puppies Sired by Approximately Twenty Per Cent. of the Stud Dogs—Popularity and Prepotency—A Cause of Variation

WILLIAMS HAYNES
Author of "Practical Dog Breeding," etc.

WHEN the cattle breeder says "the bull is half the herd" he expresses one of the fundamental differences between natural selection and the artificial selection practiced by animal breeders. Even with sheep, cattle, horses and other gregarious animals, among which, in a wild state, the stronger and more vigorous males certainly beget more offspring than their weaker rivals, artificial selection undoubtedly gives increased opportunities to the selected sires. No wild male, however superior physically to his rivals, ever sired so large a proportion of the succeeding generation as does the popular sire chosen by breeders. In the case of animals which, in a natural state, mate in pairs or in small groups, obviously this effect is very much more marked.

In order to arrive at a definite expression of this important factor in artificial selection, I have made a statistical study of three breeds of terriers, dogs offering a peculiarly good field for a study of this kind. That the results might be as typical as possible, I have selected three breeds of the same general family: all well established as to type and all generally popular all over the country. Registrations of different individuals of the same litter have been discarded, so that each unit represents an entire litter. Obviously all thoroughbred litters are not represented in the Stud Book, but I have chosen breeds in which a great number of the breeders register, and, as the average terrier litter numbers about 5.25 puppies, a considerable number of the entire population for the year must be included in these figures. The results, which are from the American Kennel Club Stud Book, Vol. XXIX (1912), can, I believe, be taken as thoroughly representative. (See table at bottom of page.)

In other words, 15.5% of the Irish terrier sires whose get was registered during 1912 sired 33.96% of the puppies; 22.77% of the Scottish terriers got 45.00% of the pups; and 24% of the fox terriers got 46.73%. For the three breeds, 19.49% of the sires got 43.20% of the puppies, or to express the totals in figures (assuming 5.25 pups to the litter) we have 818 individuals out of 1,874 sired by but 54 out of the 277 stud dogs.

Since to sire two litters can hardly be considered a mark of any particular popularity, we probably get a truer expression of the factor of popularity as such, by omitting the two litter dogs. This gives 7.94% of the stud dogs (twenty-one individuals) sireing 22.91% of the puppies (451 individuals).

The practice of dog breeders is liberal in the choice of a stud dog to which to mate their bitches. The majority do not keep a stud dog, and even those who do so, though subjected to the usual temptation to breed to their own dog (convenience, expense, and increasing his reputation as a sire), are able to enjoy wide latitude in choice. Stud fees are quite uniform and comparatively low, ranging from $15 to $25. Transportation charges on so small an

	1 Litter Each		2 Litters Each		3 Litters Each		4 Litters Each		5 Litters Each		7 Litters Each		Breed	Total
	Sires	Litters	Sires	Litters	Sires	Litters	Sires	Litters	Sires	Litters	Sires	Litters	Sires	Litters
Irish terriers........	70	70	9	18	1	3	2	8	..	..	1	7	83	106
Scottish terriers......	78	78	13	26	5	15	2	8	2	10	1	7	101	144
Fox terriers.........	75	75	11	22	3	9	3	12	..	..	1	7	93	125
Total............	223	223	33	66	9	27	7	28	2	10	3	21	277	375

MOST POPULAR LIVING SCOTTISH TERRIER SIRE

Champion Bapton Norman is considered by Mr. Haynes to be "one of the most phenomenal sires of any breed of dogs that has ever appeared;" when only three years old he had already sired three champions and nine winners of championship points or certificates. He is owned by J. Deane Willis of Bapton Manor, Codford St. Mary, Wilts., England, and many American owners have imported bitches bred to this famous dog, in order to get as much of his blood as possible in this country. (Fig. 5.)

animal are light (a terrier bitch can be sent from New York to Chicago and back for $15) and there is little inconvenience and slight risk in sending her on a considerable journey to be bred. For these reasons, dog breeders are but little restricted in selecting whatever sire their judgment dictates as the best mate for their bitches. Popularity has very free play.

But popularity at stud is, so all breeders have been often warned, a very poor indicator of breeding ability. It is therefore interesting to see whether these dog breeders, who are so notorious for following fads and fancies, have selected really important sires, or are merely attracted by show points. In each breed one dog, as the sire of seven litters, stands out markedly as the most popular stud dog of the year.

The Irish terrier is Champion Thorncroft Sportsman. That capital authority—especially strong in this his favorite breed—the late James Watson says of him in a posthumous article on dog breeding published recently,[1] "the French bulldog Nellcote Gamin and the Irish terrier Thorncroft Sportsman, ... have no such heritage of special selection[2] but control simply by individual dominance . . . and it behooves the Irish terrier fanciers and the French bulldog breeders to conserve

[1] Field and Fancy, Vol. XXXVII, No. 3, p. 12.
[2] That is, they are not dogs inbred to a special strain.—W. H.

the prepotency demonstrated in the dogs . . . to which attention has been drawn." Three years ago Irish terrier breeders had already discovered this prepotency, and as early as 1912 this dog was the most popular sire.

AN ENGLISH WINNER

The case of the most popular Scottish terrier is even more remarkable. The dog Champion Bapton Norman was at the time only three years old, but he had already sired three champions and nine winners of championship points or certificates. Since then he has proved himself to be one of the most phenomenal sires of any breed of dogs that has ever appeared, but his English breeder has refused all offers for the dog and he is still in England. That a dog in England should be represented in the American stud book by more litters than any dog in this country is unexpected. That he should be so young a dog and that he should since then demonstrate that he is one of the great sires of all time shows that a prepotent individual is sometimes discovered early and that a number of dog breeders, certainly Scottish terrier breeders, are importing for blood as well as points.

The case of the fox terrier, Sabine Reserve, is not so clear cut. As a stud dog he is hardly so prepotent an individual as either Thorncroft Sportsman or Bapton Norman, yet he is bred from that eminent producing strain founded by Champion Sabine Result, and of his get registered during 1912 one became a champion and four others were winners at the shows. Clearly, if not a phenomenal sire, he is much above the average in his heredity and in his capabilities.

When in three breeds, picked as representative, the most popular sires prove to be also important sires—two of them truly great sires—it makes one wonder if the consensus of breeders' opinions does not come closer to the mark in selecting as the popular the truly prepotent individuals, than we are prone to believe. Prepotency runs in certain families in dogs as in other animals[3] and this, being recognized by dog breeders, undoubtedly influences selection, but only indirectly. The reputation of the individual dog, both as a show winner and a sire of winners, is almost always the determining factor in a breeder's selection, but it can hardly be a coincidence that in these three breeds popularity and prepotency should have been combined.

Superficially it might appear that if approximately 40% of the puppies each year are sired by but 20% of the stud dogs this would eventually result in the greatest uniformity of type. The selected sires are all to a greater or lesser degree exceptional individuals, but they are not selected by any uniform system. Most of them excel in some particular physical point, but they do not excel in the same points or in the same degree, nor even, in some cases, in the same direction. Here the personal equation, the ideals of different breeders, is at work, and the result is that since a few males not themselves of uniform type sire a greater-than-average number of offspring they disturb the race average of the following generation and introduce abnormal amounts of variation. The fact therefore, that artificial selection gives to certain selected, but not uniform, males an undue preponderance of influence must always keep the type of domestic animals in an unstable state. This seems to me an important factor in the great variability always noted among domesticated breeds.

[3] Becker, The Great Dane (1905), p. 41; Packwood, Show Collies (1906), pp. 18, 103; Davies, The Scottish Terrier (London n.d.), Chap. IV; Graham, The Sporting Dog (1904), Chaps. II, III, IV; Haynes, Practical Dog Breeding (1915), Chap. VI.

NATURAL SELECTION IN MAN

FEW people show any hesitancy in accepting the idea that Natural Selection is constantly at work among plants and the lower animals, weeding out the weak and unfit, and allowing only those to survive who are by heredity adapted to survive in their own particular environment.

But when the same doctrine is applied to man, a great many persons have hesitated. It was something of a shock to them to admit that the death of a friend or relative might be due to unfitness to survive.

The biologist could accept the application of natural selection to man without hesitation, but many others felt that they required proof, before they could open their minds so far.

It has therefore been a chosen task of Professor Karl Pearson, of the University of London, and his school of biometricians, to bring together mathematical proof of the operation of natural selection in man.

Pearson's first contribution to the subject, some twenty years ago, was in the form of a study of the inheritance of longevity. He found, to put the case very briefly, that there was a close connection between length of life in parent and length of life in child; and from this fact, demonstrated in various strata of the population, he was able to draw the conclusion that about two-thirds of all the deaths that occur nowadays, are due to natural selection: they are the deaths of those who, through heredity, were not able to survive in their environment.

The rest of the deaths must be set down to random causes. If a man is struck by a moving train, for instance, it is evident that his hereditary make-up will have little to do with his chances of survival.

It should be noted that we can not blame environment too much for deaths which we credit to natural selection. It is not wholly that the environment was bad. Dr. Alfred Ploetz, of Munich, investigated the royal families of Europe, where the environment may be fairly supposed to be as good as possible for every child, and found that even there 60% of all the deaths were due to heredity.

It should further be noted that when we ascribe a death to heredity, we do not necessarily mean a congenital defect in the ordinary sense of the term. A congenital lack of resistance to some specific disease is equally a matter of heredity, and is often a cause of death.

INFANT MORTALITY

In 1911 Dr. E. C. Snow published the results of an investigation on the infant mortality of parts of England and Prussia, in which he showed that a high death rate during infancy was followed by a low death rate during childhood, in the same group; and vice versa. Here was another evidence of the work of natural selection: Nature was weeding out the weakest, and in proportion to the stringency with which she weeded them out at the start, there were fewer weaklings left to die in the succeeding years.

Evidence from another source was published by Pearson in 1912. He dealt with material analogous to that of Snow, and showed "that when allowance was made for change of environment in the course of fifty years, a very high association existed between the deaths in the first year of life and the deaths in childhood (1 to 5 years). This association was such that if the infantile death rate *increased* by 10% the child death rate *decreased* by 5.3% in males, while in females the *fall* in the child deathrate was almost 1% for every *rise* of 1% in the infantile death rate."

To put the matter in the form of a truism, part of the children born in any district in a given year are doomed by heredity to premature death; and if

they die in one year they will not be alive to die in some succeeding year.

These researches involved some very difficult mathematical problems, to which nothing more than an allusion can be made here. They were based on a statistical method known as partial correlations. The object of the present note is to call attention to a new study[1] of the subject of natural selection, based on a new statistical method, which Pearson says is the most important contribution to the apparatus of statistical research that has been made for a number of years past. It is termed the Variate Difference Correlation method.

Its exact nature is of interest only to mathematicians, but every geneticist will be interested in the fact that it gives, according to Pearson, a more accurate result in the study of natural selection than any method heretofore known.

RESULTS OF NEW STUDY

Applying it to the registered births in England and Wales between 1850 and 1912, and the births during the first five years of life in the same period, Miss Elderton and Professor Pearson have found that the previous observations of a selective death rate are confirmed with increased accuracy. "For both sexes a heavy death rate in one year of life means a markedly lower death rate in the same group in the following year of life." This lessened death rate extends in a lessened degree to the year following that, but is not by the present method easy to trace further.

"It is difficult," as they conclude, "to believe that this important fact can be due to any other source than the influence of natural selection, *i.e.*, a heavy mortality leaves behind it a stronger population."

To avoid misunderstandings, it may be well to close this review with the closing words of the Elderton-Pearson paper. "Nature is not concerned with the moral or the immoral, which are standards of human conduct, and the duty of the naturalist is to point out what goes on in Nature. There can now be scarcely a doubt that even in highly organized human communities the death rate is selective, and physical fitness is the criterion for survival. To assert the existence of this selection and measure its intensity must be distinguished from an advocacy of high infant mortality as a factor of racial efficiency. This reminder is the more needful as there are not wanting those who assert that demonstrating the existence of natural selection in man is identical with decrying all efforts to reduce the infantile death rate."

[1] Further Evidence of Natural Selection in Man. By Ethel M. Elderton and Karl Pearson. Biometrika, Vol. X, Part IV, pp. 488–506. London, May, 1915.

Seeks to Find Best Nut-Bearing Trees

Endeavoring to enlist members of the American Genetic Association in a search for the undeveloped nut-producing resources of the United States, Professor J. Russell Smith, of the University of Pennsylvania, writes: "We now know how to graft them, so that the finding of them amounts to something. We have most surprising resources in the shape of rare nut trees, if we just knew where they were. As an example of these unknown resources, I will cite the recent discovery *in Indiana* of three or four of the finest pecan trees in the world. It took looking to find these trees from among the thousands of wild ones, but it is true that somebody, some boy, some hunter, some observant farmer, has his eye on nearly all of the extra fine nut trees in his neighborhood. He should tell the world about them, that's all. The way is easy—simply send samples of the nuts, with an account of the tree, to the secretary of the Northern Nut Growers' Association, Dr. W. C. Deming, Georgetown, Conn. This Association wants your help so badly that it is offering money for it—$50 for a hazel tree of American origin that can compete with the imported filberts; $10 for a Northern pecan better than we now have, and $20 for other nuts that are found by judges to be sufficiently valuable."

GARDEN GLADIOLI

Most Common Varieties Are Complex Hybrids Representing a Number of Distinct Species—Success Suggests That More Species Should Be Used in the Production of New Horticultural Forms of Other Flowers[1]

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GLADIOLUS offers an excellent example of a genus of plants which has been improved for garden purposes by the incorporation of a number of species into more complex multiple hybrids than most of the flowers of the garden. The China aster (*Callistephus chinensis*), sweet pea (*Lathyrus odoratus*) peony (*Paeonia albiflora*) and Boston fern (*Nephrolepis exaltata* var. *bostoniensis*) have been improved solely by the selection of variations and mutations within a single species. Phlox, German iris, larkspur (*Delphinium*), dahlia, columbine (*Aquilegia*), begonia and chrysanthemum varieties have arisen from the hybridization of several species. The rose, orchid, pelargonium and gladiolus, however, often have in the make-up of their best varieties three to seven species, each contributing characteristics to the modern degree of perfection.

The genus Gladiolus consists of approximately 130 species, most of which are natives of South Africa, though several are of European origin. Previous to 1840, only a few forms commanded any attention horticulturally. One was the hybrid species *G. colvillei*, a rather dwarf plant with flowers characterized by a white area or lozenge in the throat, bordered by a deep color; a feature inherited directly from its parent, *G. cardinalis*. *G. tristis* var. *concolor* was used as the other parent of *G. colvillei*.

Another form was known as *G. ramosus*, a branchy plant which resulted from crossing *G. oppositiflorus* with various hybrids (now unknown) of *G. cardinalis*. *G. oppositiflorus* is a native of Madagascar and Natal, and bears a stem 3 to 6 feet tall which produces large white flowers with characteristic amethyst stripes in the throat. Twenty-four or even forty blooms are borne upon the stem, twelve of which are often open at one time. This tall, white, many-flowered species was crossed with *G. cardinalis*, a bright scarlet and rather dwarf species. The result of this crossing was *G. ramosus*, at that time thought to be quite admirable.

In 1837 Beddinghaus, gardener to the Duke of Aremberg, had growing on the estate in Engheim the *G. ramosus* hybrids, and besides these the Parrot Gladiolus, *G. psittacinus*. In this the upper segment is scarlet, with deep yellow medial line, and is also spotted with yellow at the base; the lower is rich yellow and scarlet. The plant grows to a height of three feet and is clothed for the most part by the sheathing bases of the leaves.

MYSTERY OF GHENT VARIETY

The species *G. ramosus*, *G. oppositiflorus*, *G. cardinalis* and *G. psittacinus* were crossed rather promiscuously. In 1841 a form appeared which was thought to be superb. In "Flore des Serres" was published an account of this new type, and it was said to be a hybrid between *G. cardinalis* and *G. psittacinus*. However, Dean Herbert and others, after attempts to cross these latter species, failed and declared that the new hybrid was *G. psittacinus* and *G. oppositiflorus* instead. A controversy over the parentage has raged since then, but to the writer the explanation is simple in saying that the new hybrid

[1] Address before the twelfth annual meeting of the American Genetic Association, at Berkeley, Calif., on August 5, 1915.

SAUNDERS' GLADIOLUS

This brilliant scarlet species (*G. saundersi*) has an amber white throat finely dotted. The openness of its throat is marked, and it has been particularly prized by hybridizers for that reason. It has been used in the creation of many modern garden varieties of gladiolus, to produce well open blooms and clear white throats. Adapted by Hottes from the Botanical Magazine. (Fig. 6.)

was *G. ramosus* (*G. oppositiflorus* by *G. cardinalis*) crossed with *G. psittacinus*. This is substantiated by the fact that the new form contained features from each. Louis Van Houtte obtained the stock and advertised it as *G. gandavensis*, naming it from Ghent, Belgium, and describing it in glowing terms as bearing majestic flowers, numbering eighteen to twenty, of the most charming vermilion, the inferior petals adorned with chrome, amaranth and brown. He writes: "All Ghent comes to admire it. In stateliness and color it exceeds all others we have among Gladioli."

Napoleon III was much interested in the amelioration and introduction of new plants, and so it was that *G. gandavensis* came into the possession of Souchet, gardener of the Emperor. Souchet worked with it, developed by hybridization and selection its form, color, size and arrangement of flowers until it became a valuable addition to our garden plants. *G. gandavensis* can be characterized as having many flowers open at the same time, being of great size and of good substance, having rich colors, handsome and somewhat angular form, often having light areas or penciling in the throat. The flowers are arranged in two rows on a tall spike in such a way that each flower appears attractive. The spikes are very erect and quite stiff.

Some few years previous to 1878 the species *G. purpureo-auratus* came to the attention of that master French horticulturist, Victor Lemoine, who began to use it with improved forms of *G. gandavensis*. By this time, the group had been materially improved by Souchet, Brunelet and Souillard. Lemoine immediately realized the possibilities of this species, which was introduced into France in 1872. *G. purpureo-auratus* is pale yellowish-green and bears upon the lower segments of the flower admirable diamond-shaped blotches of maroon. The flowers are bell-shaped, rather hooded, pendant, far apart and face one direction. The foliage is somewhat glaucous, narrow and stiff. The stems are slender, wiry and inclined to be curved. The corms bear many short underground stems tipped by clusters of cormels. The flower was not beautiful, but Lemoine realized that combinations of the *G. gandavensis* varieties with this new species would result in something unique.

PRINCEPS

This amaryllis-like gladiolus is one of 2,000 produced by Dr. W. Van Fleet; its interesting pedigree can be seen at the end of the text. In color it is rich crimson with a magnificent, large, white throat. From the "Modern Gladiolus Grower." (Fig. 7.)

LEMOINE'S HYBRIDS

In 1878 Lemoine exhibited at the International Exhibition at Paris a number of these hybrids and called them *G. lemoinei*. The stems are wiry,

slender, graceful, inclined to be curved, but the spikes have the ability to open only a few blooms at one time. Many of the varieties have too strong a tendency toward being bell-shaped, to the extent that the interior of the flower is not readily seen. The flowers are rather smaller than *G. gandavensis*. The colors are exceedingly rich and the lower petals of the blooms are usually blotched, a feature gained from *G. purpureo-auratus*. The blotches are deep, velvety and very striking. Enthusiasts have ventured to say that some of the richest colorings in the plant kingdom are found in the lemoinei. *G. purpureo-auratus* is about the hardiest of the African species and has contributed this quality to the hybrids. Many of them are hardy, even in the region of New York City. A moment's consideration will show that the rich petal coloring has been derived from the species *G. psittacinus;* the blotch, hardiness and graceful stem from *G. purpureo-auratus;* and the vigor, erectness, and perhaps the great number of flowers, from *G. oppositiflorus*.

Lemoine's next work was to influence the form and colorations of the *G. lemoinei* by using the species *G. saundersi* which is truly a beautifully colored species, even in its unimproved form. The flowers are brilliant scarlet with a pure white center, finely dotted scarlet. They are very open, being faulty in this respect. The plants are dwarf and weak-stemmed; six to eight large hooded flowers are borne upon a stem usually less than 2 feet tall. The leaves are short and glaucous.

Using *G. saundersi* with the best varieties of *G. lemoinei*, a new group was introduced in 1886 named *G. nanceianus* from Lemoine's home, Nancy, France. *G. lemoinei* was used as the pollen parent. Reciprocal crosses did not appear to be identical. The *G. nanceianus* varieties are characterized by being very large (larger than *G. gandavensis* or *G. lemoinei*), very well open as contrasted with lemoinei. The open flower looks one in the face, as the side segments are spreading. The throat is marked with peculiar mottlings of fine, short strokes of contrasting color. The varieties vary much in vigor, some being exceptionally strong, others very weak. They are quite hardy. The colors are excellent, brilliant or subdued according to the variety.

Max Leichtlin, of Baden Baden, Germany, admiring the species *G. saundersi*, but realizing its faults, made a series of crosses with the *G. gandavensis* varieties and obtained a few rather pretty seedlings which he sold in 1882 to V. H. Hallock who, after ten years of hybridization and improvement, sold his stock to John Lewis Childs. In 1892, Childs placed these seedlings upon the market under the name of *G. childsi*. The *G. childsi* constitute a group of large, showy-flowered varieties which possess gigantic growth, rich colors, and pretty mottled throats. At first these were somewhat lacking in substance. Many of the varieties resemble *G. gandavensis* except that they are more open; others are quite like *G. nanceianus* except for the fact that the throats of the latter are richer and more often thickly marked.

G. turicensis has the same parentage as childsi, and was originated by M. Froebel of Zürich, Switzerland; but because it has not been widely developed nor advertized, it is not of great importance.

Dr. W. Van Fleet produced a form which is much like an amaryllis in its clear, deep red. It is a cross between a childsi variety, Mrs. H. Beecher, and *G. cruentus*, and is called variety *Princeps*.

THE MAID OF THE MIST

Recently there has come to the attention of the gladiolus breeder a species from the Rain Forest near Victoria Falls on the Zambesi River, which is pale golden-yellow, primula-scented, and known as the Maid of the Mist or *G. primulinus*. This species is rather straggling in form, often three to four feet tall, and bears four to five narrow, hooded, rather small flowers. With this species many of the finest varieties of the other groups are being hybridized. Several seedlings of unusual merit have resulted from a cross between this species and the ruffled gladiolus, the

MRS. FRANK PENDELTON

In the large flowers of this variety, salmon-pink with deep blood-red blotches in the throat, can be traced the influence of a number of distinct species of gladiolus. The form of bloom is that of *G. lemoinei*, the markings are from *G. purpureo-auratus*, while the stem comes from *G. gandavensis*. From the "Modern Gladiolus Grower." (Fig. 8.)

latter a development by A. E. Kunderd, of Goshen, Ind., who produced these charming varieties by selecting blooms showing a ruffled tendency. The ruffled-primulinus hybrids are exceedingly vigorous and of excellent colors. *G. primulinus*, according to Dr. Van Fleet, who has produced over 2,000 hybrids, is dominant over the deepest reds, subduing them to pure, soft, pleasing shades of orange, salmon and terra cotta, with deep and light yellow throats. Hybridized with the whites and light colors, the resulting progeny is cream, buff, ecru, lemon and canary, often without markings. Deep yellows, in which the blotches are eliminated, result from crosses with yellows of the other groups. Most of the hybrids inherit the hooded character.

It is interesting to note that it is mainly one species which has contributed the blue color to the hybrids. This species is *G. papileo*, a purple one.

Lemoine used his *G. lemoinei* and the result was a series of more or less blue hybrids very much resembling *G. lemoinei*.

The foregoing discussion has concerned only a few of the species used, but it is hoped that the historical facts presented will show that the garden gladiolus is a multiple hybrid, resulting from a series of species each valuable for one or more dominant characteristics. Does not this bring out strongly the advisability of using a larger range of species in other plants? Each species in the practical hybridist's mind represents certain desirable characteristics to be incorporated into a hybrid. Too often there are many unfavorable features, the consideration of which is entirely neglected.

It must be admitted that greater progress can often be made with the interbreeding of established varieties, but when new features are to be added, the employment of new species is quite advisable or imperative. These should be the basis of hybridization. As years pass, the inferior seedlings may be discarded, and the ideal form may be far removed from the wild species; but the ancestor is necessary.

PEDIGREE OF SOME IMPORTANT GARDEN GLADIOLI

G. tristis x G. cardinalis x ?

G. colvillei   G. cardinalis mules x G. oppositiflorus

G. ramosus

G. hybr. cardinali-oppositiflorus x G. psittacinus

G. saundersii   x   G. gandavensis x G. purpureo-auratus

G. turicensis

G. cruentus x G. childsi

variety Princeps

G. papileo x G. lemoinei x G. saundersii

Blue Gladiolus   G. nanceianus

New Publication Planned

In order to furnish greater opportunity for the publication of the results of research in genetics, the Princeton University Press is making plans to launch a new periodical to be called *Genetics*. It is hoped that the first number can appear in January, 1916. It will be under the control of a board of editors, chief of whom will be Dr. George Harrison Shull, of the Carnegie Institution, Cold Spring Harbor, Long Island, N. Y., who has recently resigned his position there to become associated with Princeton University. *Genetics*, it is announced, will accept only technical papers, the results of original research, and will therefore not conflict with the JOURNAL OF HEREDITY, whose function is rather to interpret the results of research to those who would profit by them, but are not in a position to follow the technical literature.

PROPAGATION OF WILD BIRDS

Waterfowl Very Easy to Breed in Captivity—Gallinaceous Species Offer no Great Difficulties—Benefits and Profits from Breeding—Bird Refuges

Review of a Book by

HERBERT K. JOB

Economic Ornithologist in Charge of the Department of Applied Ornithology of the National Association of Audubon Societies.

THERE seems to be among students of nature, nowadays, a widespread desire to assist nature in "running things." The plant lover is no longer content with inspecting the flowers of the field: he wants to grow them in his own garden, often under rigorously controlled conditions. The student of animal life is unlikely to spend all his time in the woods or meadows, as he often did a quarter century ago. If he wants to be in the fashion, zoölogically, he is too likely to spend all his time in a laboratory, and he will give preference to animals that can be kept in cages or tanks, for with them he will come as near as possible to seeing everything he wants to see.

For a long time the bird lovers stood out against this passion for breeding, which had taken hold of the botanists and zoölogists. Ornithologists continued to pursue their studies in the field, and there was little demand even for commercial breeding.

But in the last ten years, the students of birds, too, have succumbed to the desire to get nearer to nature than a stroll in the woods makes possible. All over the country they are using devices to attract the birds to their own dooryards; and those who possess means are in many cases undertaking breeding experiments on a large scale, sometimes as a commercial, sometimes as a sporting proposition.

So long as it does not lead to a neglect of wild life in its natural environment, the modern naturalist's desire to take up breeding deserves every encouragement. Plant and animal breeders have long been able to get abundant advice in printed form, and bird lovers are now to be congratulated on having a book,[1] "The Propagation of Wild Birds," which seems likely to meet their needs.

Herbert K. Job, its author, was formerly State Ornithologist of Connecticut, and is now in charge of the Department of Applied Ornithology of the National Association of Audubon Societies. Much of the success in rearing wild birds in captivity nowadays is based on Mr. Job's own experiments, and he describes them and others in a business-like way, so simply that no one can misunderstand.

The rearing of gallinaceous birds such as the quail, pheasant and turkey, is probably the most important, and for these, Mr. Job warns his readers, a good deal of room is necessary. "Experiment has shown conclusively that all kinds of wild gallinaceous birds can be kept in health in confinement. Most kinds cannot, however, with safety, be closely confined in *small* quarters, like domestic fowl. Under such conditions they are very susceptible to various diseases, especially of the digestive tract, which are likely to become epidemic. To these the domesticated species have become considerably immune. Some species require more room and range than any others and cannot stand any crowding. Another matter of importance is that the same ground surface must not be used for too long a period continuously."

[1] Propagation of Wild Birds, a Manual of Applied Ornithology, by Herbert K. Job. Pp. 276, illustrated. New York, Doubleday Page & Co., 1915.

CALIFORNIA OR VALLEY QUAILS

The birds which have made a friend of Ruth, daughter of Superintendent Dirks of the State Game Farm of California, belong to a different species from the "bob white" of the East; their plumed heads lend them an air of particular dignity. The California species gathers in large flocks, and has a gentle, confiding disposition which makes it well suited to breeding in captivity. From Job, "Propagation of Wild Birds." (Fig. 9.)

"When one has decided to raise birds, the question is how to secure breeding stock. In the case of various foreign species, notably pheasants and the gray or Hungarian partridge, these are readily purchased. With native species, however, the case is different. Most States have forbidden the shipment and sale of native game. There is an occasional game commissioner or chief warden who grants special permission to secure a few birds for propagation only.

"Though there is a real difficulty at present, the problem will undoubtedly soon be solved. Laws are being passed in various States to encourage, under proper supervision and regulation, the propagation of game as an industry. Many people are now making small beginnings, and before long will have breeding-stock for sale. The high prices for live birds will for some time to come make it more profitable to sell them for breeding than for food purposes, except with such common species as the ring-necked pheasant and the mallard."

A start could often be made with birds taken in the hunting season slightly wounded in the wing. Sometimes permission has been given to take a few eggs, which can then be hatched under a bantam. It is also possible to secure some birds, particularly quail, from Mexico, and contrary to expectation these have proved quite hardy in New York State.

Breeding the native quail or bob-white on a large scale is decidedly to be recommended, the author says, in view of the value of the bird to agriculturists as well as to sportsmen. The problems

in connection with it have been pretty thoroughly worked out; "the main thing has been to learn what precautions are necessary to avoid the outbreak of epidemic diseases."

Privacy is of primary importance with this bird. "They are exceedingly secretive in habits, particularly in mating and breeding, and skulk nearly all the time under cover, unless convinced that no observer is near."

AVOID OVERCROWDING

"In a 5 or 6 acre enclosure at the Clove Valley Club I saw 2,000 young phesants raised without danger. But quails would certainly not stand anything like that amount of herding. We do not yet know how far we can go with numbers and crowding, and this is to be worked out. Till this is done, it is well to be cautious with the rearing-field system, using, preferably, fields of moderate size and more of them. For the present, I should not try to keep more than half a dozen broods in a field of half an acre. For other broods it will be safer to scatter the coops in the open about the estate, preserve or farm."

Summarizing, Mr. Job advises that quail can be successfully bred as follows:

"1. Secure breeding stock in the late fall or early winter either by purchase or by capture of a small stock by permission of the authorities.

"2. Keep these through the winter in a wire enclosure with simple shelter from storms and cold winds.

"3. In April separate the pairs, having each pair in a small pen by itself. Some can remain in the larger pen together, if there are not enough small pens.

"4. Hatch out the eggs and raise the young with bantams. Do not attempt incubators and brooders.

"5. Put the breeders back into the large pen together by the latter part of July, unless they wish to incubate.

"6. In late fall or early winter catch up what young are desired. The rest can be left wild to breed naturally next summer. Feed regularly under shelters throughout the winter, to hold them on the land, as also by planted areas of grain left standing for them. In severe winter weather coveys might be shut up and cared for, and let go again."

The grouse family, including the "partridge" and ptarmigan of the North, the "prairie chicken," the heath-hen, etc., offers another attractive field. These birds become very tame in domestication—in fact, the tameness of young

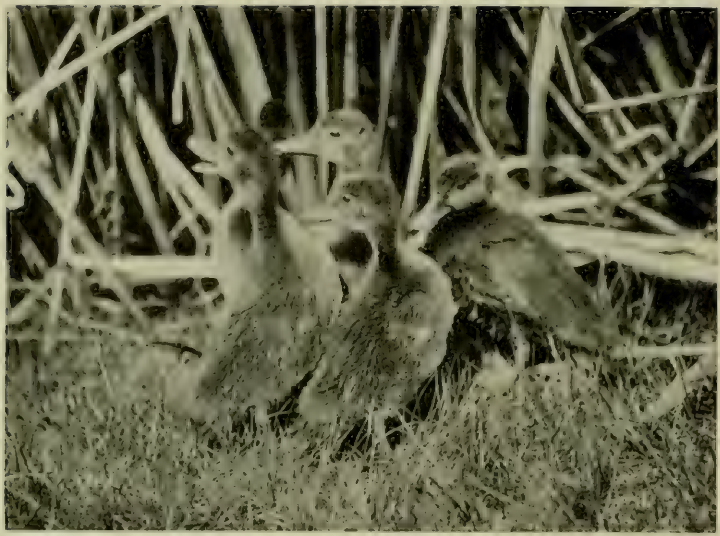
YOUNG QUAIL WATCHING A FLY

Quails are usually reared in captivity from eggs incubated by bantam hens. Except for the possibility of certain contagious diseases, quail breeding offers no great difficulties, and is of great benefit from an agricultural as well as a sporting or commercial standpoint. From "Propagation of Wild Birds," by Job. (Fig. 10.)

which are hatched and bred in captivity is so great as to render them almost helpless under natural conditions, until they have had a chance to learn the ways of the wild.

THE WILD TURKEY

For many reasons, the wild turkey has attracted a number of breeders. It is not so near extinction, in a state of nature, as most people think, but it



YOUNG REDHEAD DUCKS IN MANITOBA

In order to learn, under the most favorable conditions, how to rear wild ducks in captivity, Mr. Job made two expeditions to Northern Canada. This photograph shows some of the young redheads, hatched in incubator from eggs found in nests in the woods, and then brought to maturity in brooder. Among the American wild ducks, he has found the redhead one of the easiest to raise, owing to its hardiness and docility. From Job, "Propagation of Wild Birds." (Fig. 11.)

deserves to be increased. Mr. Job declares that many of the birds now killed in the woods are hybrids with the domestic turkey, and that much of the breeding stock sold under the name of wild turkey is really of mongrel origin. The differences between the two forms are, of course, slight. The birds are easily domesticated, and when not crowded they appear to be little more difficult to rear than is the ordinary barn-yard turkey.

But the pheasant family, in Mr. Job's opinion, is preëminently the species for would-be propagators to begin with. It is more easily raised than any other game bird of the gallinaceous group, it is wonderfully hardy, and it has much commercial value. "At present indications it seems likely to become one of the principal game birds of America."

Methods are much the same as for quail. The birds will stand a good deal of crowding, though not so much as poultry. The large and brilliant birds are an attraction to any estate; furthermore they are distinctly profitable.

"It is a pleasant way for young people to make a little money on the side by raising a few game birds or waterfowl. With hardly any expense, on the average farm, a boy could have a few broods of pheasants roaming around and growing up. What little work there is will seem more like sport, and the watchfulness required is good training. After buying the original breeding stock, the expense is very light. Little apparatus is required, and the birds are small eaters. Ring-neck stock will probably cost $5 to $6 per pair in the late fall. A cock and four hens, say, might cost from $10 to $15. These should lay at the very least 120 eggs, which are worth usually 25 cents each, or more than double the cost of the original stock. If even a moderate number of young are reared and sold, the undertaking would considerably more than pay.

AN EXHIBIT "TO ENCOURAGE THE OTHERS"

Crows are often a pest to game breeders, because of their fondness for birds' eggs, and their tendency to destroy young birds. Although they do some good, the game breeder usually regards them as more of liability than an asset. A Connecticut farmer has killed a number of them and hung them on a tree as a warning to their brethren. From Job, "Propagation of Wild Birds." (Fig. 12.)

"The demand for live pheasants from the many that are beginning to breed them is so great that there is an almost unlimited market at present for them alive. When this demand is finally met, there is still an enormous field for sale for food purposes as wild game."

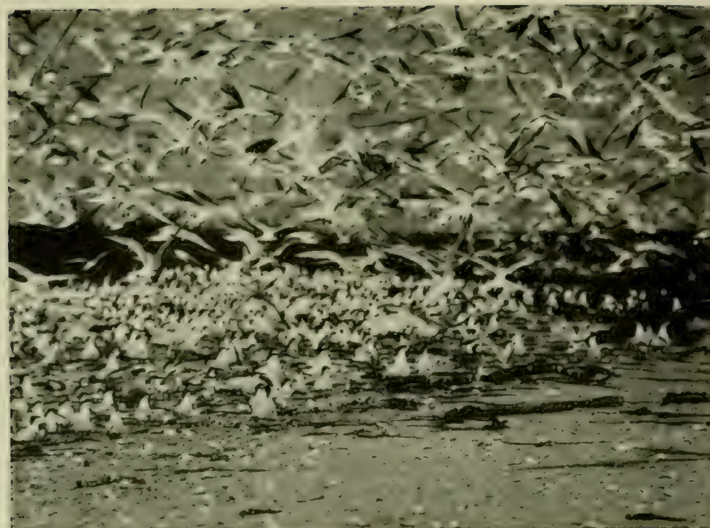
One of the difficulties which every breeder has to face is the activity of small animals which, however valuable they may be from some other point of view, are to the bird breeder merely "vermin."

WAR ON VERMIN

"A popular fallacy," Mr. Job remarks, "is that all it is necessary to do to increase bird life is to set apart a tract of wild land as a refuge, and prohibit trespass and shooting. At the start there are probably few birds, and after ten years there might not be any more. One reason is that the average wild land abounds with destructive vermin. Hawks and owls, which are the principal natural check upon the smaller mammals, have been so reduced in numbers that rats and other vermin abound. True they kill some birds, but they eat more of the enemies of the birds. Because we have upset the balance of nature, we have to help restore it by checking the abnormal increase of vermin." Practical suggestions for destroying these pests are given.

But if the breeding of gallinaceous birds offers no unsurmountable problems, waterfowl are still easier to rear, according to the author.

"The simplicity of the keeping of wildfowl is one of the delightful surprises in store, though it must be borne in mind that there will be failure unless certain fundamental principles are carried out. About all that is needed is a little pond or brook, especially in a



ROYAL TERNS FLOURISH UNDER PROTECTION

Breton Island, off the coast of Louisiana, has been set aside as a refuge for wild fowl, and is patrolled by the National Association of Audubon Societies, who take care that nothing shall interfere with the natural breeding of the birds. This photograph shows royal terns during the breeding season. Many such reservations have been established in all parts of the United States during recent years. From Job, "Propagation of Wild Birds." (Fig. 13.)

quiet, sheltered place and with some marshy ground, perhaps a simple, open-front poultry shed, and a cheap wire fence. The food also is simple and easy to provide. It is easy to maintain the birds in health, when properly handled, for they are hardy, and seldom have epidemics comparable to those of the gallinaceous birds, though similar disasters may occur if the water is allowed to become foul and stagnant and reasonable sanitation is not observed. The young also are comparatively easy to rear."

"Anyone who has even the facilities of a city back yard, with a cement basin and a little shrubbery, could have a few pairs of pinioned wild ducks which would breed in happy contentment. F. N. Manross, of Forestville, Conn., has a little artificial basin under the windows of his factory, surrounded by some thick, low shrubbery and a wire fence. There a pair of beautiful wood ducks, regardless of noise or human presence, each year raise a brood of young, and furnish their owner delightful distraction from business cares. A steam pipe keeps the water partly open in winter, and there they live the year round, with no shelter other than shrubbery and a small box. In another part of the yard he has a couple of pairs of Canada geese, originally wild, which live there in perfect contentment."

WILD GEESE EASILY TAMED

"It is a surprise to many who consider wild geese the type of inherent wildness that in reality they are tamed more readily than almost any other wild bird, even than ducks, submitting even in shorter time and becoming more absolutely familiar. This is notably true of the common wild goose or Canada goose. Wing-tipped geese which are captured will in a short time become so tame that they will hardly get out of the way.

"It is a curious anomaly, however, that while the Canada goose, as a species, breeds readily in captivity, all the other species of native wild geese

are very hard to breed, notwithstanding the fact that they all become perfectly tame."

Most of the wading birds are hard to breed, for various reasons, one of which is the amount they eat. Mr. Job describes his experience with a woodcock which weighed 6 ounces and consumed daily from 8 to 12 ounces of earthworms. Several boys spent their spare time digging worms for the bird, but after a month Mr. Job became disgusted and liberated him. As he says, the idea of feeding a whole flock of woodcocks staggers the imagination.

The same objection prevents the breeding of herons or egrets for their plumes. "The enormous appetite of herons for fish would make the thing commercially unprofitable even if herons were induced to breed in captivity. E. A. McIlhenny, of Avery Island, La., is experimenting now with herons in a large flying cage, to see if they will breed in captivity. He says that each bird eats 1½ pounds of fish a day, on the average, and it has cost $12 per year to feed each bird."

Cranes are readily kept in confinement, and it is becoming fashionable to have them on country estates. They are expensive, however, and do not breed.

BIRD REFUGES

One aspect of breeding which deserves note is the establishment of refuges and protected colonies. "A splendid movement, which has gathered momentum in the past few years, is the establishment of reservations on tracts of marsh and swamp land, unsuited to human occupancy, where wildfowl can gather and feed in winter and be safe from molestation. Well known already are the Ward-McIlhenny tract in Louisiana and that of Marsh Island, donated by Mrs. Russell Sage. Latterly comes the vast tract under the Rockefeller Foundation adjoining the above in this great marsh region. Together these comprise some 500 square miles, and extend for 75 miles along the coast. Already ducks have begun to breed there in considerable numbers, according to Mr. McIlhenny—the blue-winged teal, gadwall, black duck, and mallard, and probably others in time will join them. Similar measures should be taken, even if on a smaller scale, in every state of the Union. The wildfowl should also be protected on their breeding grounds, wherever these are located. Some breed in the United States, but most of them in the northwest provinces of Canada, and it is ardently to be hoped that through treaties with our neighbors, both on the north and south, a comprehensive continental protection and conservation of this important and valuable asset may be made possible."

There are already, Mr. Job notes, nearly sixty protected areas set aside in various parts of the country by the Federal Government, as water-bird breeding colonies. The National Audubon Society undertakes the work of policing them, and also guards various other rookeries which are not national reservations. Thousands of individuals are doing similar work on their own land.

The concluding portion of Mr. Job's book is given over to a description of means by which the smaller wild birds can be attracted and induced to remain around houses and on farms. To many readers, this is likely to be the most valuable and interesting part of the book. In this, as well as in the preceding sections, the author wastes little time on generalities, but gives detailed and specific directions for meeting each individual problem that is likely to arise.

Eugenics in the Colleges

Perhaps Kalamazoo College, in Michigan, can claim to have taught eugenics as long as any college in the United States. Professor W. E. Praeger, of the Department of Biology, writes that it has been a part of the curriculum for nine years. There has been a special course in genetics for the past three years; before that the subject was part of the course entitled Theoretical Biology. Lectures in eugenics are also given in the course on hygiene, required of all freshmen.

MATERNAL IMPRESSIONS

Belief in Their Existence Is Due to Unscientific Method of Thought—No Evidence Whatever That Justifies Faith in Them—How the Superstition Originated

THE EDITOR

IS THERE a short cut to eugenics? This association stands committed to the belief that eugenics is a phase of genetics; that it is, therefore, an applied science. Anything which calls itself eugenics, but which is not scientific, should expect only hostility from us.

To be scientific, nothing more is necessary than that a doctrine should be based on accurate observation of facts, and correct inferences from those facts.

As the experience of most of us is limited, and as our beliefs and reasoning are unconsciously influenced by our hopes and fears, and by prejudices which we absorb during childhood, it is no cause for astonishment that some ideas should be widely current and accepted almost without protest which, when examined by a really scientific method of thought, seem absurd. I wish to apply this process to a very widespread popular belief, which is being urged by many sincere and often influential persons as a "short cut" method of race betterment.

I refer to what is commonly called maternal impression, pre-natal culture, "marking," and so on. It is no novelty, but goes back beyond history. In the book of Genesis[1] we find Jacob making use of it to get the best of his tricky father-in-law. Some animal breeders still profess faith in it as a part of their methods of breeding: if they want a black calf, for instance, they will keep a white cow in a black stall, and express perfect confidence that her offspring will resemble midnight darkness.

It is easy to see that this method, if it "works," would be a potent instrument for eugenics. And it is being recommended for that reason. Says a recent writer, who professes on the cover of her book to give a "complete and intelligent summary of all the principles of eugenics:"

"Too much emphasis cannot be placed upon the necessity of young people making the proper choice of mates in marriage; yet if the production of superior children were dependent upon that one factor, the outlook would be most discouraging to prospective fathers and mothers, for weak traits of character are to be found in all. But when young people learn that by a conscious endeavor to train themselves, they are thereby training their unborn children, they can feel that there is some hope and joy in parentage; that it is something to which they can look forward with delight and even rapture; then they will be inspired to work hard to attain the best and highest that there is in them, leading the lives that will not only be a blessing to themselves but to their succeeding generation."

MANY ADHERENTS

The author of this quotation has no difficulty in finding supporters. Many physicians and surgeons, who are supposed to be trained in scientific methods of thought, will indorse what she says. The author of one of the most recent and in many respects admirable books on the care of babies, a woman who

[1] Chapter XXX, verses 31–43. A knowledge of the pedigree of Laban's cattle would undoubtedly explain where the stripes came from. It is interesting to note how this idea persists: I had just completed the present paper when I received from a correspondent the account of seven striped lambs born after their mothers had seen a striped skunk. The actual explanation is doubtless that suggested by Heller in the JOURNAL OF HEREDITY, VI, 480 (October, 1915), that a stripe is part of the ancestral coat pattern of the sheep, and appears from time to time because of reversion.

occupies a position of national importance in the "Better Babies" movement, is almost contemptuous in her disdain for those who think otherwise:

"Science wrangles over the rival importance of heredity and environment, but we women *know* what effects prenatal influence works in children." "The woman who frets brings forth a nervous child. The woman who rebels generally bears a morbid child." "Self-control, cheerfulness and love for the little life breathing in unison with your own will practically insure you a child of normal physique and nerves."

Such statements, backed up by a great array of writers and speakers whom the layman supposes to be scientific, and who think themselves scientific, cannot fail to influence strongly an immense number of mothers and fathers. If they are truly scientific statements, their general acceptance must be a great good.

But think of the disillusionment if these widespread statements are false!

Have we, or have we not, a short cut to race betterment? Everyone interested in the welfare of the race must feel the necessity of getting at the truth in the case; and the truth can be found only by rigorously scientific thought.

Let us turn to the observed facts. I find this sample in the health department of a popular magazine, quite recently issued:

"Since birth my body has been covered with scales strikingly resembling the surface of a fish. My parents and I have expended considerable money on remedies and specialists without deriving any permanent benefit. I bathe my entire body with hot water daily, using the best quality of soap. The scales fall off continually. My brother, who is younger than myself, is afflicted with the same trouble, but in a lesser degree. My sister, the third member of the family, has been troubled only on the knees and abdomen. My mother has always been quite nervous and susceptible to any unusual mental impression. She believes that she marked me by craving fish, and preferring to clean them herself. During the prenatal life of my brother, she worried much lest she might mark him in the same way. In the case of my sister she tried to control her mind. Could we transmit this condition[2] to our children?"

THE MARK OF THE MEAT MARKET

Another I find in a little publication which is devoted to eugenics.[3] As a "horrible example" we are given the case of Jesse Pomeroy, a murderer whom older readers will well remember. His father, it appears, worked in a meat market. Before the birth of Jesse, his mother went daily to the shop to carry a luncheon to her husband, and her eyes naturally fell upon the bloody carcases hung about the walls. Inevitably, the sight of such things would produce bloody thoughts in the mind of the child!

These are extreme cases; let me quote from a medieval medical writer another case that carries the principle to its logical conclusion: A woman saw a negro—at that time a rarity in Europe. She immediately had a sickening suspicion that her child would be "marked," that he would be born with a black skin. To obviate the danger, she had a happy inspiration—she hastened home and washed her body all over with warm water. When the child appeared, his skin was found to be normally white—except between the fingers and toes, where it was black. His mother had

[2] Such a skin affection is usually due to heredity. Davenport says it "is especially apt to be found in families in which consanguineous marriages occur and this fact, together with the pedigrees [which he studied], suggests that it is due to the absence of some factor that controls the process of cornification of the skin. On this hypothesis a normal person who belongs to an affected family may marry into a normal family with impunity, but cousin marriages are to be avoided." Technically the disease is known as icthyosis, xerosis or xerodoma. See Davenport, C. B., Heredity in Relation to Eugenics, p. 134. New York, 1911.

[3] Of course, their eugenics is to be effected through the mental exertion of mothers. And I am now in correspondence with a western attorney who is endeavoring to form an association of persons who will agree to be the parents of "willed" children. By this means, he has calculated (and sends me a chart to prove it) that it will require only four generations to produce the Superman.

failed to wash herself thoroughly in those places!

Of course, few of the cases now credited are as gross as this; but the principle involved remains, so far as I can see, the same.

We will take a hypothetical case of a common sort for the sake of clearness: the mother receives a wound on the arm; when her child is delivered it is found to have a scar of some sort on the corresponding arm, and at about the same place. Few mothers would fail to see the result of a maternal impression here. But how could this mark have been transmitted? We are not here concerned with the transmission of acquired characters through the germ-plasm, or anything of that sort, for the child was already formed when the mother was injured. We are driven, therefore, to believe that the injury was in some way transmitted through the placenta, the only connection between the mother and the unborn child; and that it was then reproduced in some way on the child, at a place corresponding to that where it appeared in the mother.

NO MEANS OF TRANSMISSION

Here we have a situation which, examined in the cold light of reason, puts a heavy enough strain on the credulity. But what most mothers may forget is that there is not a single nerve or blood-vessel passing through the placenta, from mother to child. Not a drop of the mother's blood passes to her unborn offspring. The child does indeed derive all its nourishment from the mother, but it is by soakage from her blood to its own; there is no direct connection. No one has ever traced a single nerve or blood vessel passing through. Is it conceivable to any rational human being, that a scar, or what not, on the mother's body (or mind), can be dissolved in her blood, soak through the placenta into the child's circulation, and then gather itself together into a definite scar on the infant's arm?

There is just as much reason to expect the child to grow to resemble the cow on whose milk it is fed after birth, as to expect it to grow to resemble its mother, because of pre-natal influence, as the term is customarily used—for once development has begun, the child draws nothing more than nourishment from its mother.

Of course we are accustomed to the pious rejoinder that man must not expect to understand all the mysteries of life; we are accustomed to hearing vague talk about the wonder of wireless telegraphy. But in wireless telegraphy we have something very definite and tangible—there is little mystery about it. We have waves of a given frequency sent off, and caught by an instrument attuned to the same frequency. How any rational person can support a belief in maternal impressions by such an analogy, if he knows anything about anatomy and physiology, passes comprehension.

Now I am far from declaring that we can find a reason for everything that happens. Science will not refuse belief in an observed fact merely because it is unexplainable. But let us examine this case of maternal impressions a little farther. What can we learn of the time element?

THE TIME ELEMENT

Immediately we are confronted with the significant fact that most of the marks, deformities and other effects which are credited to pre-natal influence must *on this hypothesis* take place at a comparatively late period in the ante-natal life of the child. The mother is frightened by a dog; the child is born with a dog-face. If we ask *when* her fright occurred, we usually find it not earlier than the third month, more likely somewhere near the sixth.

But it ought to be well known that the development of all main parts of the body has been completed at the end of the second month. At that time, the mother rarely does more than suspect the coming of a child. Her anxiety about the child, and events which she believes to "mark" that child, usually occur after the fourth or fifth month, when the child is fully formed, and it is *impossible* that many of the effects supposed to occur could

actually occur. Indeed, we now believe that most errors of development, such as lead to the production of great physical defects, are due to some cause within the embryo itself, and that most of them take place in the first two or three weeks, when the mother is by no means likely to influence the course of embryological development by her mental attitude toward it, for the very good reason that she knows nothing about it.

Unless she be immured or isolated from the world, nearly every expectant mother sees many sights of the kind that, according to popular tradition, cause "marks." Why is it that results are so few? Why is it that women doctors and nurses, who are constantly exposed to unpleasant sights, have children that do not differ from those of other mothers?

Darwin, who knew how to think scientifically, saw that this is the logical line of proof or disproof. When Sir Joseph Hooker, the botanist and geologist who was his closest friend, wrote of a supposed case of maternal impression, one of his kinswomen having insisted that a mole which appeared on her child was the effect of fright upon herself for having, before the birth of the child, blotted with sepia a copy of Turner's "Liber Studiorum" that had been lent her with special injunctions to be careful, Darwin[4] replied: "I should be very much obliged, if at any future or leisure time you could tell me on what you ground your doubtful belief in imagination of a mother affecting her offspring. I have attended to the several statements scattered about, but do not believe in more than accidental coincidences. W. Hunter told my father, then in a lying-in hospital, that in many thousand cases he had asked the mother, *before her confinement*, whether anything had affected her imagination, and recorded the answers; and absolutely not one case came right, though, when the child was anything remarkable, they afterwards made the cap to fit."

Any doctor who has handled many maternity cases can call to mind instances where every condition was present, to perfection, for the production of a maternal impression, on the time honored lines. None occurred. Most mothers can, if they give the matter careful consideration, duplicate this experience from their own. Why is it that results are so rare?

THE SEARCH FOR COINCIDENCE

That Darwin gave the true explanation of a great many of the alleged cases is perfectly clear to us. When the child is born with any peculiar characteristic, the mother hunts for some experience in the preceding months that might explain it. If she succeeds in finding any experience of her own at all resembling in its effects the effect which the infant shows, she considers she has proved *causation*, has established a good case of pre-natal influence.

It is not causation; it is coincidence. If the prospective mother plays or sings a great deal, with the idea of giving her child a musical endowment, and the child actually turns out to have musical talent, the mother at once recalls her yearning that such might be the case; her assiduous practice which she hoped would be of benefit to her child. She immediately decides that it did benefit him, and she becomes a convinced witness to the belief in pre-natal culture. Has she not herself demonstrated it?

She has not. But if she would examine the child's heredity, she would probably find a taste for music running in the germ-plasm. Her study and practice had not the slightest effect on this hereditary disposition; it is equally certain that the child would have been born with a taste for music if its mother had devoted eight hours a day for nine months to cultivating thoughts of hatred for the musical profession and repugnance for everything that possesses rhythm or harmony.

It necessarily follows, then, that attempts to influence the development of the child, physically or mentally, through "pre-natal culture," are doomed to disappointment. The child develops along the lines of the potentialities which existed in the two germ cells that united to become its origin. The

[4] Life and Letters of Charles Darwin, Vol. I, p. 302, New York, 1897. The letter is dated 1844.

course of its development cannot be changed in any definite way by any act or attitude of his mother.

It must also necessarily follow that attempts to improve the race on a large scale, by the general adoption of pre-natal culture as an instrument of eugenics, are useless.

Indeed, the logical implication of the teaching is the reverse of eugenic. It would give a woman reason to think she might marry a man whose heredity was rotten, and yet, by pre-natal culture save her children from paying the inevitable penalty of this weak heritage. We have long shuddered over the future of the girl who marries a man to reform him; but think what it means to the future of the race if a superior girl, armed with correspondence school lessons in pre-natal culture, marries a man to reform his children!

MISSPENT ENERGY

Those who practice this doctrine are doomed to absolute disillusion. The time they spend on pre-natal culture is not cultivating the child; it is merely cultivating a superstition. Not only is their time thus spent wasted, but worse, for they might have employed it in ways that really would have benefited the child—in open-air exercise, for instance.

For those who preach this doctrine, with the belief that they are aiding the prospective mother or furthering the improvement of the race, we must feel sympathy and pity, as for all misguided efforts at well-doing.

Their only excuse for this divorce from science is failure either to recognize the facts involved, or to make correct inferences from these facts. That the latter explanation applies in most cases, we know because we find many persons holding a belief in the reality of maternal impressions, who are perfectly well aware of the facts in the case. And these facts, which they well know, seem to me wholly to preclude any deductions which will support the belief that pre-natal culture is anything better than a superstition. To recapitulate, the facts are:

(1) That there is, before birth, no connection between mother and child, by which impressions on the mother's mind or body could be transmitted to the child's mind or body.

(2) That in most cases the marks or defects whose origin is attributed to maternal impression, must necessarily have been complete long before the incident occurred which the mother, after the child's birth, ascribes as the cause.

(3) That these phenomena usually do not occur when they are, and by hypothesis ought to be, expected. The explanations are found after the event, and that is regarded as causation, which is really coincidence.

These facts, accompanied by the application of rigorous logic, seem to me to prevent anyone from accepting as true the current belief in maternal impressions.

And yet, because it is logically impossible to prove a universal negative, we cannot absolutely prove that such a thing as a maternal impression never happened and never can happen. We can only appeal to each individual to exercise his capacity for scientific thought, with an open mind, and decide for himself whether it is absurd to believe that the strawberry mark on the child's arm is due to his mother's appetite for strawberries.

But is it conceivable, we are often asked, that such an idea would have survived, widespread in the human race, for so many thousands of years, unless there were some basis of truth under it?

HOW THE IDEA AROSE

Certainly there is a basis of truth under it. The embryo derives its entire nourishment from the mother; and its development depends wholly on its supply of nourishment. Anything which affects the supply of nourishment will affect the embryo *in a general, not a particular* way.

Now if the mother's mental and physical condition be good, the supply of nourishment to the embryo is likely to be good, and development will be normal.

If, on the other hand, the mother is constantly harassed by fear or hatred, her physical health will suffer, she will be unable properly to nourish her developing offspring, and it, when born, may by its poor physical condition indicate this.

Further, if the mother experiences a great mental or physical shock, it may so upset her health that her child is not properly nourished, its development is arrested, mentally as well as physically, and it is born feebleminded. Goddard, for example, tells[5] of a high-grade imbecile in the Training School at Vineland, N. J. "Nancy belongs to a thoroughly normal, respectable family. There is nothing to account for the condition unless one accepts the mother's theory. While it sounds somewhat like the discarded theory of maternal impression, yet it is not impossible that the fright and shock which the mother received may have interfered with the nutrition of the unborn child and resulted in the mental defect. The story in brief is as follows: Shortly before this child was born, the mother was compelled to take care of a sister-in-law who was in a similar condition and very ill with convulsions. Our child's mother was many times frightened severely as her sister-in-law was quite out of her mind. She says that this child's ways often recall to her the sister-in-law's actions at that time."

We can easily understand that any event which makes such an impression on the mother as to affect her health, might so disturb the normal functioning of her body that her child would be badly nourished, or even poisoned. Such facts are not antagonistic to scientific thought; and they undoubtedly form the basis on which the airy fabric of pre-natal culture was reared by the hands of those who lived before the days of scientific biology.

ALLEGED CASES EXPLAINED

Thus, it is easy enough to see the real explanation of such cases as those mentioned by the "Better Babies" expert, near the beginning of this paper. The mothers who fret and rebel over their maternity, she found, are likely to bear neurotic children. It is obvious (1) that mothers who fret and rebel are quite likely themselves to be neurotic in constitution, and the child naturally gets his heredity from them; (2) that constant fretting and rebellion would so affect the mother's health that her child would not be properly nourished.

When, however, she goes on to draw the inference that "self-control, cheerfulness and love . . . will practically insure you a child normal in physique and nerves," we are obliged to stop. We know that what she says is not true. If the child's heredity is bad, neither self-control, cheerfulness, love, nor anything else known to science, can make that heredity good.

At first thought, we may wish it were otherwise. There is something inspiring in the idea of a mother overcoming the effect of heredity by the sheer force of her own will-power. But the idea is merely a hallucination, and perhaps in the long run it is as well: for there are advantages on the other side. It should be a satisfaction to mothers to know that their children will not be marked or injured by untoward events in the ante-natal days; that if the child's heredity cannot be changed for the better, neither can it be changed for the worse.

The pre-natal culturists and maternal-impressionists are trying to place on her a responsibility which she need not bear.

Obviously, it is the mother who is most nearly concerned with the bogie of maternal impressions, and it should make for her peace of mind to know that it is nothing more than a bogie.

It is important for the expectant mother to keep herself in as nearly perfect condition as possible, both physically and mentally. Her bodily mechanism will then run smoothly, and the child will get from her blood the nourishment needed for development, in proper quantity and proper quality. Beyond that, there is nothing the mother can do to influence the development of her child. There is not a shred of evidence to support the idea that

[5] Goddard, H. H. Feeblemindedness, p. 359. New York, the Macmillan Company, 1914.

a child's mental or physical character can be influenced in the slightest degree for better or for worse *in any definite way*, by the mental attitude of the mother before its birth.

Maternal impressions and pre-natal culture are not facts, but superstitions. They owe their continued existence to a lack of scientific thought. To realize their falsity, no deep researches are necessary: nothing more is needed than a knowledge of some elementary facts, and scientific thought about those facts.

Scientific thought, Clifford[6] told us, "is not an accompaniment or condition of human progress, but it is human progress itself."

No one, I venture to declare, has human progress more at heart than has the eugenist. It must, therefore, be to the interest of every eugenist to see that the superstition of maternal impression is driven out of existence.

[6] Clifford, W. K. The Aim and Instruments of Scientific Thought. Address before the British Association for the Advancement of Science, at Brighton, August 19, 1872.

International Congress of Genealogy

The International Congress of Genealogy which met in connection with the Panama-Pacific International Exposition in San Francisco from July 27 to 30, represented sixty-five genealogical, historical, patriotic, heraldic and family associations and had accredited to it about 275 delegates elected by these organizations. In addition, there were many others interested in genealogy, but not officially accredited, who attended the congress. The Utah Genealogical Society sent to the meeting a special train carrying 269 persons from Utah.

The program provided that the congress should meet the week following the national convention of the American Historical Association and the week preceding the annual meeting of the American Genetic Association and the Second International Conference of Race Betterment. It also provided for meetings in San Francisco of family associations during or as near as possible to the time of the genealogical congress. Some of the latter were held.

This plan and the genealogical congress, first of its kind ever held, were proposed by the Hon. Boutwell Dunlap, of San Francisco, recording secretary of the California Genealogical Society. He first proposed an International Congress of Genealogy and Eugenics. Not desiring to conflict with other eugenic organizations, the name of the congress was later restricted to the International Congress of Genealogy. The invitations to the congress and family associations were issued jointly in the names of the Panama-Pacific International Exposition and the California Genealogical Society.

Some of the organizations that elected delegates to the congress were the National Society of Americans of Royal Descent, Society for the Preservation of New England Antiquities, College of Arms and Seigneural Court of Canada, American Society of Colonial Families, New England Historic Genealogical Society, Huguenot Society of America, Louisiana Historical Society, Maine Genealogical Society, Historical Society of New Mexico, Order of Founders and Patriots of America, Society of Genealogists of London, National Genealogical Society, National Society of the Sons and Daughters of the Pilgrims, National Society of Sons of the Revolution.

An International Genealogical Federation was formed and a resolution affecting eugenics, introduced by Mr. Dunlap and unanimously adopted by the congress, was as follows:

"Resolved, that one of the objects of the International Genealogical Federation shall be the collection and preservation of genealogical data for eugenic purposes and that the committee of organization of said International Genealogical Federation is hereby instructed to provide for the said collection and preservation of genealogical data for eugenic purposes."

ANCESTRY OF THE GOAT

Modern Breeds All Descendants of a Single Species—Great Success Attained in Breeding This Species in Two Distinct Directions, for Milk and Hair

OF ALL important domesticated animals, the goat is distinguished by the simplicity of his ancestry. The modern horse, or ox, or dog, or sheep, is the product of the combination of a number of distinct species, but the European goat can trace his pedigree directly back to a single form.

It is, then, a matter of particular interest to breeders, to see what wide variations have been produced within the limits of one species, under domestication.

Geologically speaking, both the goats and their near relatives the sheep, were late in appearing on the earth. There must be a form somewhat intermediate between sheep, goats and antilopes, which we do not now know, but the first goat fossils, according to R. Lydekker, are of species allied to those now living in the Himalayas, and are found in Pliocene or late Tertiary deposits in the Panjab and the Siwalik hills of India. In the succeeding or Pleistocene epoch, remains of an ibex, one of the best-known wild goats, are found in the plains of Central Europe.

The distinction between sheep and goats was thus made at a comparatively late time in the history of the earth: even now it is not a broad one, for although the typical domesticated goat is distinguished without difficulty from the typical domesticated sheep, there are wild forms which stand almost half way between the two. The blending of the two species has always been the despair of zoölogists, who sought for some well-marked characters to distinguish them. The great French naturalist, Sanson, after discarding one by one all the characters which he studied, finally reached the desperate conclusion that the tail was the only feature by which a goat could be told from a sheep, that member, as every one knows, being short and erect in the goats, moderately long and carried in the normal position by sheep.

A GENETIC TEST

Proposals to lump the sheep and goats as a single genus have been frequently put forward, but always rejected by the body of zoölogists, largely, it may be believed, on the ground of convenience. To a genetist, the question would depend partly on whether the two forms breed together and result in fertile offspring. This is one of the moot points of animal husbandry—a somewhat astonishing fact, considering how many opportunities there should be for getting information.

On the one hand, there are those who claim that a real hybrid between the two forms is unknown; on the other we have stories of districts in Russia and Chile (or other parts of South America) where it is alleged that a hybrid form makes up the bulk of the flocks. Examinations of some of these flocks by zoötechnists have led to conflicting opinions as to whether they were really hybrids or not.

In the *American Breeders' Magazine* for 1913 (Vol. IV, No. 1, p. 69), W. J. Spillman, of the U. S. Department of Agriculture, described and figured an animal raised by E. Arnaud, of Monet, Mo., which he believed to be a true sheep-goat hybrid; it was one of a pair, and its twin was distinctly an ordinary sheep. Similar cases have often been reported, but even if they are accepted, they must be regarded as isolated, and it seems fair to say that interbreeding of the sheep and goat is at least very rare; whereas the different species of

ANCESTOR OF THE GOAT

Pasang or Grecian Ibex, a wild goat found in Asia Minor, Persia and adjoining countries. It is the belief of naturalists that this form, which is easily tamed, was domesticated at some time before the dawn of history and has given rise to all the numerous breeds of goat now found in Europe and America. Its improvement appears to have been by simple selection in two directions—to increase the yield of milk and to increase the yield of hair. From Lydekker. (Fig. 14.)

wild and tame goats interbreed freely and yield perfectly fertile progeny.[1]

To the genetist, then, the evidence that sheep and goats should be separated is fairly good. Zoölogists have found a few other characters that serve them more or less constantly: for example, the face of the goat has no crumen or tear-bag, which is usually, though not invariably, present on that of the sheep. And whereas all sheep have pores or glands between the hoofs of each foot, in the goats such glands are found only in the forefeet, and even there may be wanting.

The beard of the male, and the characteristic odor, are signs of great convenience to the layman in distinguishing goats from sheep.

The goat genus (*Capra*) is generally credited with a dozen species, and among these it is almost the consensus of opinion that a single one may be considered the ancestor of European (and

[1] L. L. Heller, of the Bureau of Animal Industry, U. S. Department of Agriculture, informs me that the bureau some years ago tried crossing goats with sheep, both males and females of each species being used. The breed of sheep chosen was the Barbados, as primitive in type as any in the United States, and it was thought that this breed should prove fertile in crosses with goats, if any would. There were no offspring from any of the matings. Mr. Heller believes the so-called hybrids that have been produced from time to time are merely reversions.—The Editor.

MALE, IMPROVED TYPE OF MILK GOAT

The greatest development of goats for milk has taken place in Switzerland, where the two famous breeds, Toggenburg and Saanen, were produced. The photograph of Toggenburg Bill No. 442 shows a typical buck of the former breed. Good does of this breed will produce several quarts of rich milk daily, while one owned in California has set a world record with a daily production of six quarts—a record which thousands of cows in the United States fail to attain. Photograph from the U. S. Department of Agriculture. (Fig. 15.)

thence, American) domesticated goats. This is variously known as the Bezoar,[2] Pasang[3] or Grecian Ibex, while the zoölogists have an even greater range of synonyms, *Capra hircus aegagrus* being now the most widely accepted technical name.

THE PASANG AT HOME

Once common throughout Greece and Asia Minor, as is shown by its mention in Homer, the Pasang has now been crowded back, although it still lives on a few of the Mediterranean islands, notably on the slopes of Mount Ida in Crete. Its habitat today may be said to be Persia, Afghanistan and Baluchistan, although it is by no means extinct in the mountains of Asia Minor.

The slender, graceful animal, whose height at the shoulder is approximately three feet, is well shown in the accompanying drawing (Fig. 14). The general ground color of the upper parts is

[2] Bezoar is properly the name of a product in high repute among medieval medical men; it is a compound of bile and rosin, which forms a concretion in the stomach of the goat, and thence gave its name to the species from which it was most often obtained. The name is properly pa-zahr, from pao, to purify, and zahr, poison, and these "stones" were believed to have the power to draw poison from the bite of a snake, the sting of a scorpion, etc. There is still some commerce in them in India and other parts of the orient. Needless to say, they are valueless for medicinal purposes; and they are so easily counterfeited by a compound of pipe-clay and ox-gall that the market for them is in a bad state.

[3] Pasang means "rock-footed" and is supposed to be the Persian designation of this species; but as a fact it appears nowadays to be called merely boz-i-kohi, "mountain goat."

brownish-gray in winter, reddish-brown in summer, becoming paler in old males; the under parts are whitish.

It ranges solitary or in parties of from ten to twenty up to a hundred. "During summer," says Lydekker,[3] "the old bucks keep to the higher mountains, being frequently found in snow, while the does and kids frequent lower elevations. In winter both sexes keep more together, living at elevations of from 2,000 to 3,000 feet, on rocky ground among bushes or scattered pines. In certain districts they may descend almost to sea level.

"Although at other times shy and wary, during the pairing season they may be approached with ease and may be attracted within range by a concealed hunter rolling a few stones down the hillside. If surprised they utter a short snort and immediately make off in a canter. Their agility among rocks is little short of marvelous, but if driven down to the lowlands they can be easily caught with dogs, as is done in Afghanistan. When danger threatens, the oldest male takes command of the herd, and carefully surveys the line of advance or retreat before permitting the others to follow. Grass, the young shoots of dwarf oaks and cedars, and berries constitute their staple food in these districts. The kids, which are usually either one or two in number, are born in May."

The Pasang is easily domesticated, and the first domestication must have been thousands of years ago. This probably took place in Western Asia; from thence, Lydekker thinks, it was carried over into Africa, where it has departed very widely from the original type.

ARRIVAL IN EUROPE

Presumably the animal was brought into Europe by some of the earliest immigrants, but whether from Africa or from Asia, no one can say with confidence. Its remains are abundant in the early period of the Swiss lake dwellings, which go back perhaps as far as 4,000 B.C., but in the later part of this period they become rarer, indicating that the goat industry suffered a decline in those times. This, it is suggested, was due to the increasing prosperity of the population; for the goat has always been "the poor man's cow," and even today it is noticed that among African natives, goats are kept by the poorer tribes, but as they increase in prosperity they tend to give up goats and take to sheep instead.

The goat of the Swiss lake dwelling, according to C. Keller,[5] was somewhat smaller than the modern animal, and had horns. But there is some evidence that the goat of the Bronze Age was larger than that of the Stone Age, undoubtedly due to the selection of prehistoric breeders.

In the Roman period, a distinctly new form appears, an improvement of the old one, which nevertheless had not disappeared. This new form, as far as can be judged from the remains, was a sort of "thoroughbred;" it was, says Keller, unquestionably a product of conscious breeding and artificial selection, and seems to have come up from the Mediterranean lands. It is little different, he declares, from some of the types still to be found in Switzerland.

In the early days of Greece, goats were widely kept, as is proved by evidence of many kinds, but by the advent of the classical period, the industry had shrunk and been largely supplanted by sheep.

"In the kingdom of the Pharaohs the goat breeding was of great importance, for we learn from extant documents that a landlord received from his superintendent 5,023 head of live stock, of which 924 were sheep and 2,234 goats; the goat industry was therefore of considerable size. Lumbermen felling sycamores, whose trunks furnished wood for coffins and other purposes, took goats with them and fed the latter on the leaves of the cut trees."[6]

Since those days the breeding of goats has gone on in many regions, and all sorts of changes have been produced

[3] R. Lydekker, Wild Oxen, Sheep and Goats. London, Rowland Ward, Ltd., 1898.
[5] C. Keller, Naturgeschichte der Haustiere. Berlin, Paul Parey, 1905.
[6] Keller, p. 181.

GOATS IMPROVED FOR HAIR PRODUCTION

The famous Angora breed originated in Asia Minor, but is now found in large numbers in the United States. The short coat of the Pasang has been developed to an extraordinary extent—the fleeces shown in the above photograph represent a growth of only seven months after the last shearing. Two and a half or three pounds of hair a year is an average yield for Angoras, but in some cases yields of ten or twelve pounds per animal are reached by letting the hair grow for two or three years. It is now worth about 35 cents a pound. Photograph from the U. S. Department of Agriculture. (Fig. 16.)

in its appearance; due, we must suppose, to the preservation of fortuitous variations. One of the most significant was the disappearance of the horns, a mutation of which any breeder must recognize the advantage, and which it was therefore worth while to preserve. The famous modern milk-breeds of Switzerland are hornless, but from time to time a pair of horns appears—a reversion to the ancestral habit.

Another peculiar trait which appeared at some time in domestication is the beard on the female. In most, if not all, the domesticated breeds both sexes have beards, while in the wild races this mark is confined to the males.

It has been often suggested that wild species have been crossed into the domesticated goat, and help to account for some of the diverse forms. But when the alleged cases are examined, it is usually found that the supposed wild blood is really that of tame goats who have run wild. Although it can not be denied that wild blood may have come in from time to time, it seems unlikely that any wild species except the Pasang really has an appreciable share in the ancestry of the goats known to Europe and America. This cannot be said with such confidence of the Malayan and Kashmir goats, where other wild species very likely have had a share in the production of the modern forms.

While the goat has in all times been of value as a meat producing animal, it is obvious that the effort of his breeders, during many centuries, has been in two general directions: to improve the yield of milk and to improve the yield of hair.

INCREASED MILK YIELD

Credit for the first achievement goes principally to the peasants of the Swiss valleys, who have produced a number of races that are now known all over the world. Foremost among these are the Saanen, from the Obersimmental, and the Toggenburg, from the canton of St. Gall. Starting with an animal whose milk yield was little more than that of most wild animals, they have produced does that, at their best, surpass the milk yield of a good many cows. As far as is known, this result has been achieved through simple selection of the best in each generation, as breeding stock.

Breeding for hair was accomplished principally in Asia Minor, where the town of Angora gave its name to the best known breed. The way in which the short hair of the Pasang has developed into the extraordinarily long hair of the Angora is not wholly clear, but it seems again to be due to simple selection of variations in the direction that the breeder sought.

There is nothing to indicate that the goat is particularly variable in its wild state, or that its breeders have had the advantage of any unusual variations, which do not occur in most animals. Probably easy domesticability has tended, as much as anything, to give the Pasang this important place in modern animal husbandry—an importance partly measured by the calculation that there are at least 80,000,000 goats under domestication in the world, of which only about 20,000,000 are in Europe and far less than that in the United States. It must be remembered too, that most of these are in possession of persons who have only a few animals each—it is not often that one finds a large herd of goats in the possession of one man, if we except the Angora herds in the western States of America.

In the field of live-stock breeding, there are to be found few more successful examples than that of the Pasang, bred on two different lines, and in each case with such remarkable results.

AN UNUSUAL PERSIMMON TREE

The persimmon (*Diospyros virginiana*) is known to most Americans as a small tree, often only a shrub; and most authorities on forestry state that it reaches a maximum height of 50 feet and diameter of 1 foot. Michaux remarks, "The persimmon varies surprisingly in size in different soils and climates. In the vicinity of New York it is not more than half as large as in the more Southern States, where, in favorable situations, it is sometimes 60 feet in height and 18 or 20 inches in diameter." But here is a specimen near Luxora, Ark., which is 7 feet in circumference, and is estimated to be 130 feet high. The absence of limbs on most of the trunk is probably due to the fact that the tree was crowded, and was obliged to go high in order to get sunlight. It is standing in a field of cotton and was photographed on October 6, 1914, by S. E. Simonson of Luxora. (Fig. 17.)

THE TREE THAT OWNS ITSELF

That Georgia possesses the only tree in the world that owns itself, was mentioned in the September issue of the JOURNAL OF HEREDITY by W. H. Lamb. Professor T. H. McHatton, of the State College of Agriculture, Athens, Ga., thereupon sent in the above photograph of the tree. "It is a fine, healthy white oak (*Quercus alba*)," he writes; "It is 12 feet 2 inches in circumference at 5 feet from the ground and about 60 feet high. The following is the inscription to be seen on a marble slab at the base of the tree:

" 'For and in consideration of the great love I bear this tree and the great desire I have for its protection for all time, I convey to it entire possession of itself and all land on 8 feet of the tree on all sides.—William H. Jackson.'

"Of course, in the State of Georgia a plant may not own itself; but being something out of the ordinary the will has been allowed to stand and should this tree be molested in any way there would certainly be trouble. The city takes care of it, sees that it is pruned when it needs it; has placed granite posts about its 8 feet of estate and connected them with iron chains." (Fig. 18.)

THE EFFECTS OF SELECTION

THE well known maize breeding experiments at the Illinois Agricultural Experiment Station represent, it is said, the longest continued breeding experiment now in existence, with that cereal, which ranks second only to rice in its importance as a food crop of the world. L. H. Smith describes some of the results as follows:

"Starting in 1896 with an ordinary variety of corn that contained at that time 10.9% protein, there has been produced after seventeen years a strain which now contains 14.83%, while on the other hand by selection for low protein there has been produced another strain which contained in last year's crop 7.71% protein. In other words, by the method of continuous selection of seed there have been gradually developed out of the original variety two quite different kinds of corn, one of which is practically twice as rich in protein as the other.

"Again, starting with this same variety of corn which contained originally 4.7% oil, it has been possible to produce a strain that contained in the crop of last year an oil content of 8.15%; whereas, selecting in the opposite direction has resulted in a strain that analyzed last year 1.9% oil. Or, expressed in other words, by this method of breeding, it has been possible to start with a single variety of corn, and produce two different sorts, the one of which is now more than four times as rich in oil as the other.

"In 1903, a variety of corn was taken for selection to modify the height at which the ear is borne, and selection for high ears and for low ears has continued since that time. Because of two unfavorable and rather abnormal seasons during the past two years, the results have not been so striking as those obtained in 1912, when the ears of the high-ear strain were borne at an average height of 78 inches from the ground, as compared with 25 inches in the corresponding low-ear plot. Thus there was an average difference amounting to over 4½ feet, a most graphic demonstration of the power of selection in corn to influence certain characteristics with respect to habit of growth.

"Another line of selection affecting habit of growth was begun in 1904 in which the endeavor has been to modify the angle at which the ear hangs on the stalk. In one strain the selection has always been for ears standing erect while in a corresponding strain the seed has been chosen from ears that hang downward. The comparison is made each year by measuring the angle at which the ear declines from the perpendicular. Last season's results gave an average of 66 degrees for the erect ears as compared with 124 degrees for the declining. This particular habit is one that is easily affected by environmental disturbances and this last year's results are not so striking as that obtained two years ago when the average difference in angle between the two strains amounted to 73 degrees.

"Still another line belonging to this same general category of selection to modify physical characteristics of the corn plant is that which was started ten years ago to develop from an ordinary single-eared variety a strain which should bear two ears to the stalk. In the season the first selection was made, the proportion of two-eared stalks was only 2½%. This proportion has been very materially increased, varying greatly in different years with the environmental influences, but on the whole showing a marked response to the selection so that last season the proportion of two-eared stalks was the highest that has yet been attained, namely 73%.

"In addition to the experiments above described to modify through the method of continuous selection these physical and chemical characteristics of corn, there is being conducted a comprehensive fundamental study of heredity in maize with reference to the unit characters and their modes of transmission. This investigation is being conducted mainly by the method

of hybridizing varieties of diverse characters and observing the resulting Mendelian phenomena. Hundreds of separate independently transmissible characters are being observed and the study of them is leading to a knowledge of some highly important principles. For example several detrimental characters such as partial or complete lack of chlorophyl, barrenness, sterility, and others which may have a more or less direct practical bearing upon yield, are included in this study of unit characters.

"This same kind of analytical study is being extended to several of our other field crops such as wheat, oats, clover, alfalfa, soy beans, millet, broomcorn, sorghum, and sweet clover."

A number of promising strains of wheat and oats have been isolated at the same station, and it is hoped that they will soon be ready to appear in the trade. It is calculated that eight years, on the average, are required to multiply and test a new strain of cereal sufficiently to establish it, if it is worthy.

The soy bean, a legume that is gradually coming into favor in Illinois because of its use in crop rotation, is getting a good deal of attention, and appears to be particularly responsive to selection, which is directed in two different lines: to make beans valuable for oil production, and to improve them for human food.

Some Apple Statistics

Variation in apples has been investigated at the Massachusetts agricultural experiment station, the entire crops borne by certain Baldwin and Ben Davis trees being measured for six successive years. As expected, a great difference was found in the productivity of different trees, and a slight difference in the amount of variability. It is possible that the larger the apples a tree bears, the more variable they are. The apples from the upper south parts of the trees, which were largest, were also the most flattened, and there is found to be a pretty constant relationship between the form of the apple and the temperature for a period of several weeks following the bloom; the cooler this period, the more elongated the apple. The station now has Mendelian experiments under way with peas, beans and squashes, and has made much progress in breeding rust-proof asparagus, in coöperation with the federal department of agriculture. The garden pea study has shown that the ordinary commercial varieties are composed of many different strains or pure lines; work is now being carried on to determine whether selection within the pure line can increase or decrease vine length, and to determine the degree of correlation between weight of seed and length of vine. The study of the squash has also shown the common varieties to be of heterogeneous composition and the particular point now under investigation is to determine whether homozygous races may be isolated. The study of the inheritance of pigmentation and other characters in garden beans during the last six years has embraced more than 100 crosses of sixteen varieties, and included more than 50,000 plants, all of which have been carefully studied and tabulated.

Inheritance of Bad Temper

In Bulletin No. 12, I, of the Eugenics Record Office (Cold Spring Harbor, L. I., September, 1915), Dr. C. B. Davenport presents a study of the family history of 165 wayward girls, with a view to determining the heritability of violent temper. He concludes that "The tendency to outbursts of temper—'tantrums' in adults—whether more or less periodic or irregular and whether associated with epilepsy, hysteria or mania, or not, is inherited as a positive (dominant) trait, typically does not skip a generation and tends, ordinarily, to reappear, on the average, in half of the children of an affected parent."

The

Journal of Heredity

(Formerly the American Breeders' Magazine)

Vol. VI, No. 12 December, 1915

CONTENTS

The Journal of Heredity is published monthly by the American Genetic Association (formerly called the American Breeders' Association) for the benefit of its members. Canadian members who desire to receive it should send 25 cents a year, in addition to their regular membership dues of $2, because of additional postage on the magazine; foreign members pay 50 cents extra for the same reason. Subscription price to non-members, $2.00 a year, foreign postage extra; price of single copies, 25 cents.

Entered as second-class matter February 24, 1915, at the postoffice at Washington, D. C., under the act of August 24, 1912.

Date of issue of this number, November 26, 1915.

ICE MELTING FROM A TWIG

Ice forms on trees during a rain, particularly when the temperature of a thin layer of air on the ground is below freezing, but the temperature of the air above is warmer, thus preventing the rain from turning to sleet. In this photograph (highly enlarged) the ice has begun to melt, and in doing so clearly reveals its crystalline structure, the typical angles seen being those of a hexagon. From a photograph by David Fairchild. (Frontispiece.)

WHAT IS A BREED?

Definition of Word Varies with Each Kind of Livestock, and is Based Almost Wholly on Arbitrary Decision of Breeders—Some Strange Contradictions—The Meaning of "Pure-Bred"[1]

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IT IS the custom in legal documents to achieve unmistakable clearness of meaning by multiple repetition of words, and synonymous words and phrases. This method of securing clearness is distasteful to the scientific writer, and discussions and dissertations aiming to define the scope and set the limits of scientific words are numerous and lengthy. Some classic biological examples of terms of this sort are the words: species, hybrid, race, variety, etc. A kindred term which has served its purpose long and well is the word *breed*, and it may be worth while to give this word further attention.

The term "breed" is in such common use that most persons, on invitation, would be quick to explain its meaning and even ready to offer an exact definition of the word. For those who take pleasure in formulating terse, concise definitions of common terms the above word presents an interesting problem. If the person is a scientist, he must especially be on his guard, for it must be remembered that this is a term which arose among breeders of livestock, created, one might say, for their own use, and no one is warranted in assigning to this word a scientific definition and in calling the breeders wrong when they deviate from the formulated definition. It is their word and the breeders' common usage is what we must accept as the correct definition.

This sounds simple enough, but when we begin a search to discover what the "common usage" is we are dismayed at the varied and loose meanings which the breeders have given to this word.

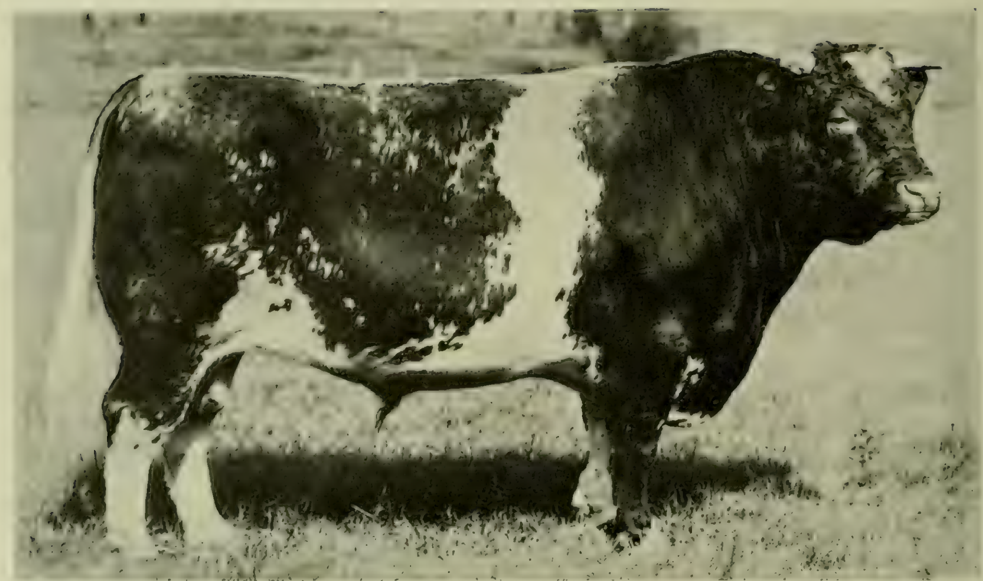
We find that a great divergence of opinion, as to what a breed may include before it must be subdivided, exists between the breeders of different classes of livestock. For instance, Shorthorn cattle can be any of four colors, and Percheron horses have a choice of half a dozen, but each breed remains a homogeneous unit without subdivisions on the basis of color. With smaller animals the lines are more finely drawn. In case of poultry, for example, the colors are kept separate, as distinguishing features of a strain, under the name of varieties, but several of these varieties are grouped together as a breed. We have white, barred, buff, or partridge varieties of the Plymouth Rock breed, and of Wyandottes I believe there are about a dozen varieties differing from each other in color, pattern, feathering, or comb shape.

Thus in poultry the breeds are composite, made up of several subdivisions, although the range of variation may be no greater, or even far less, than that found within a single breed of the large mammals. Breeders of "pet stock" rabbits, guinea-pigs, and especially of dogs, use the word "breed" in a very reckless fashion, and an attempt to divine their exact understanding of the term would be in many cases well nigh hopeless.

But to add to the confusion, breeders of the same class of livestock in different parts of the world do not always adhere to the same usage. The case of the Leicester sheep serves as a good illustration of this point.

In England there are two sorts of sheep which are connected by a certain

[1] Presented to the Agricultural Club of Iowa State College in February, 1915.



RINGMASTER, GRAND CHAMPION SHORTHORN BULL, 1913

The Shorthorn is a breed with wide limits; it takes in a number of different colors and types which in other branches of the animal industry would be considered distinct breeds. But when it comes to lack of horns, the Shorthorn breeders draw the line, as the next illustration shows. (Fig. 1.)

degree of kinship in "blood," but which are now, and for the past sixty years have been, recognized as distinct breeds. The two breeds referred to are the English Leicester and the Border Leicester. They differ from each other in size, ancestry (the Border Leicester having received some characters from the Cheviot breed), general activity, fecundity, and manner of wooling, to an unmistakable extent. Both the Scotch Highland Society and the English Agricultural Society provide separate classes and awards for them at the agricultural shows, and there are two distinct registration associations, each of which maintains a flock book for its own breed. In America, however, we speak only of the Leicester breed of sheep. The two sorts are shown together at fairs, often freely crossed, and are registered in the same flock book. They are here simply regarded as different "families" of the Leicester breed.

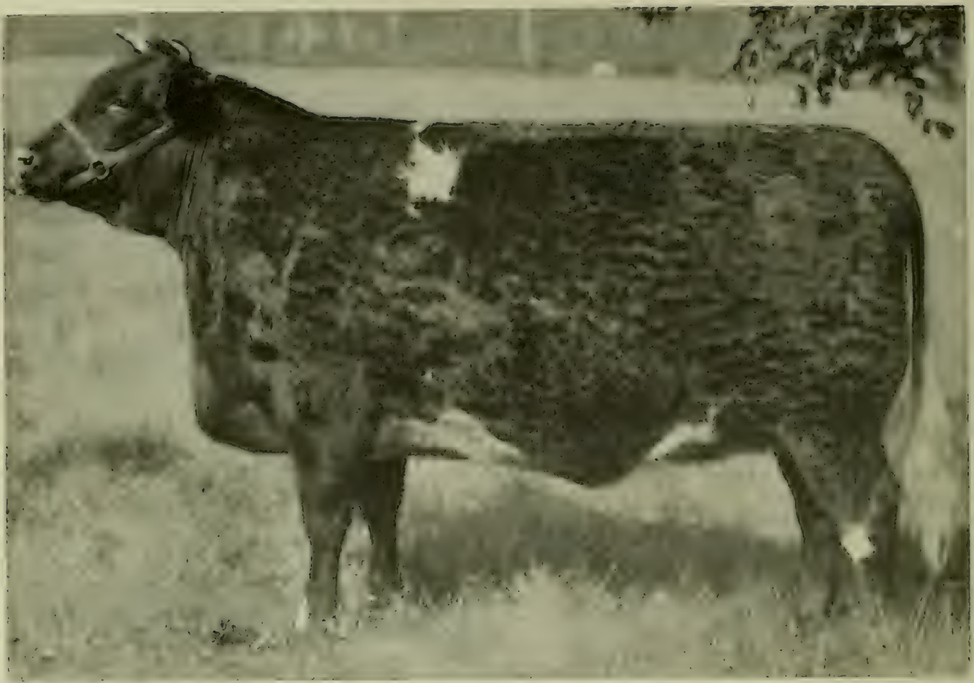
There is no fixed, commonly accepted degree of difference which serves to typify and separate the breeds. This can be illustrated by citing cases of the two extremes. First, types which differ widely between themselves may be included within the boundaries of a single breed.

Poland China breeders recognize the distinct varieties which they speak of as the "large type" and "small type." The differences between the two are constant, deep-seated, and striking, but the members of both types are all of the undivided Poland China breed. A similar "dimorphic" condition exists within the limits of the Jersey breed of cattle.

But perhaps the most striking case of this sort is furnished by the Shorthorn breed of cattle. The Milking Shorthorn is profoundly different from the strictly Scotch-bred beef animal. The difference between these two types involves, besides three possible color factors, pronounced and easily recognized peculiarities of shape and also of function. Furthermore, these two types usually differ clearly from each other in ancestry. The pedigree of the typical Milking Shorthorn will generally trace

SULTAN'S CREED, GRAND CHAMPION POLLED DURHAM BULL, 1913

Genetically, the Polled Durham is nothing but a Shorthorn without horns. This difference is due to a single factor in heredity, as the analysis of breeding experiments shows. It is one of the smallest differences on record which have sufficed for the establishment of a distinct breed, and is a difference which may exist between full brothers who resemble each other in every other respect. A comparison of the above animal with the Shorthorn shown in Fig. 1 will show that they conform minutely to the same type. The horns form the only significant difference between them, and they are of little significance as far as the value of the animal is concerned. Sultan's Creed and Ringmaster might actually have been born twins—it is a genetic possibility—but they must go through life as members of different breeds because of the difference in one factor, which affects the horns. Photograph from the owner, J. H. Miller, Peru, Ind. (Fig. 2.)



MONARCH'S VICTORIA, A BEEF TYPE SHORTHORN

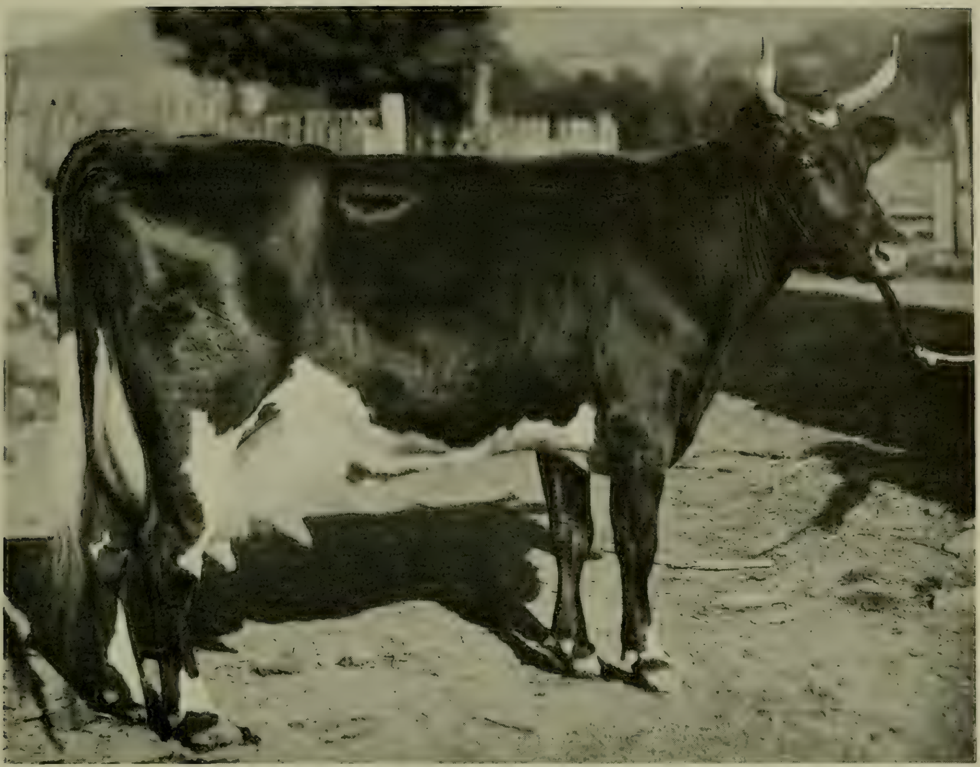
Champion Shorthorn heifer at the Chicago International Stock Show in 1913, she represents the prevailing American idea of a good Shorthorn, intended to produce meat, not milk. Every line of her form proclaims the fact that she is not a dairy cow. But if anyone thinks that the Shorthorn "breed" cannot produce dairy animals he is mistaken, as the illustration opposite will prove. (Fig. 3.)

back to the breeding of Thomas Bates, while the specialized beef animal shows predominantly in its pedigree only animals of Cruickshank or Booth breeding, the lines of lineage frequently running entirely separate for the past fifty years. But the limiting confines are very elastic and, despite these far-reaching differences, the integrity of the Shorthorn breed has not yet been disrupted on this basis.

TRIVIAL BREED BARRIERS

Second: On the other hand, types which show minute similarity may belong to separate breeds. Back in the Miami Valley of Ohio, in the mother country of the world-famous Poland China hog, there are many herds of Poland Chinas that retain the spotted pattern characteristic of all early Poland hogs. These pigs boast the same ancestry and the same type as their aristocratic "pure-bred" cousins. They are the true, reliable, rent-paying Poland China sort; paint over their white spots and they would defy detection in many a high class Poland China herd. But their spots make them outcasts, and to enable them to get inside the boundaries of a breed it is necessary that they set up a standard of their own. As a result, the Spotted Poland China breed is a reality.

It is particularly interesting that Shorthorn breeders, so generous and broad-minded in accepting wide variants into the ranks of their breed and so reluctant in permitting a cleavage of the group, also furnish an example under this head. For a variation has appeared among Shorthorn cattle which is deemed of sufficient moment for creating a separate breed. In this case, the excuse for splitting the breed is a simple difference of structure, which is known to act as a simple Mendelian unit character, *i.e.*, the



MAMIE'S MINNIE, A MILK TYPE SHORTHORN

This animal represents a family of Shorthorns that has been bred with a view to milk production, not beef production. Her record in 1913 was 14,838 pounds of milk, in 1914, 16,201 pounds, a record better than that of many fine members of the Jersey or other dairy breeds. Between this animal and the one shown on the opposite page there is scarcely a single feature of type or conformation in common. The differences between a Jersey and Guernsey cow, for example, are negligible in comparison. Yet these two cows are "breed" sisters, and might appear on the same page of the herd book. Such a contrast as this illustrates graphically the point that a breed is whatever its adherents want to call it; it is not a biological division. Photograph from the owners, May and Otis, Granville Centre, Pa. (Fig. 4.)

polled condition. Animals may be identical in form, function and even ancestry, but if they differ in respect to the presence or absence of horns, one may belong to the Polled Durham breed and the other will be merely a Shorthorn. These two types are exhibited separately in the shows, they are recorded in separate herd books and are recognized officially and in text-books of the day as distinct breeds of cattle.[2]

Lastly, we find that what is ordinarily considered as the most reliable feature to which we may hold fast in our conception of a breed, that is, degree of kinship among animals of a group, is not at all a safe means to delimit a breed. The oldest and most honored of the registry associations—that maintained for Shorthorn cattle in England—accepts today as members of the breed animals which have but fifteen-sixteenths of Shorthorn ancestry. The rules of the Morgan Horse Association admit the entry of animals with only one thirty-second of the blood of Justin

[2] It should be said, however, that many good Polled Durhams are entered in the Shorthorn herd book, as well as in that of their own breed. This double registry is not altogether unknown iu some other breeds.

Morgan, with certain reservations as to the other ancestors; while until recently the American Saddle Horse Association was ready to receive animals from whatever source or breeding as bona fide breed members if they were able to successfully execute five distinct gaits under the saddle. Furthermore, animals which themselves had never traveled under the saddle, but had produced several "performers," were eligible.

TWINS OF DIFFERENT BREEDS

The above cases are examples of animals with very slight degree of kinship belonging to the same breed, but the opposite may also be true. That is, animals with "100% the same breeding" may belong to separate breeds. We will again choose an illustration from the Shorthorn breed. Two animals may have the same sire and the same dam, and yet one will be registered in the Polled Durham herd book, while the other will be limited to the Shorthorn registry. It might easily happen that two calves would be actually born as twins and yet these two animals would be known and referred to throughout their lives as members of two distinct so-called "breeds."

It will be said that the Leicesters are grouped together in this country for purely economic reasons; that the American saddle horse is merely repeating the historic stages of every new breed in opening its books so wide; that livestock men when "pinned down" will confess the Polled Durham to be simply a sub-breed; and that the Poland China breeders are privileged to draw up whatever rules they choose in regulating their own registration.

The above comments are true in every case, but the situation remains unchanged. It is simply the usage of the word *breed* which has been called to account in the above paragraphs and not the usefulness of the boundary lines which breeders have set up between the different groups of animals. With the latter, the writer does not here take issue. It is plain, however, that mere statements to the effect that two animals are members of the same breed, or that two other animals belong to different breeds, have very little value in themselves as means of describing the likeness or unlikeness in type or kinship of the two animals. It is further necessary to know just what breed or breeds are referred to before one can form an idea of the degree of difference or similarity to be expected between the two animals.

The word *breed* has no biological meaning; it is bandied about by different classes of men in different places in the world without uniform regard to either type or kinship of the animals referred to. Its whole meaning is entirely dependent on the action of the rules committee of the breed association. A breed is whatever the breeders want to call it, there are no natural boundaries, and no arbitrary ones that are universally accepted.

A breed is a group of domestic animals, termed such by common consent of the breeders, and in formulating a universal definition no person can go very much further without usurping a right which is not justly his.

WHAT PURE-BRED MEANS

The significance of the derivative, *pure-bred*, may well be considered at this time. When a group of animals becomes sufficiently set off to be called by common consent a breed, a number of breeders unite themselves into an association. A charter is secured from the Government, a breed record or register is established, and rules of eligibility for entry into the same are set down in the by-laws. Thus the breed is definitely delimited and from this time, but not before this time, the term *pure-bred* can be correctly and safely applied to individual specimens. There is no natural boundary and breeders must await the arbitrary and official one. *A pure-bred is an animal entered or eligible to entry in the association books, or descended from such animals.*

The history of the Percheron breed of horses is interesting in this connection. Draft horses from France were early imported into this country and in 1876

an association was formed for their registry. But it soon developed that more than one kind of draft horse existed in France and that a motly array of horses was being offered for entry into the American book. A bitter dispute arose concerning eligibility of horses for record. All admitted that a *breed* existed, but no one could give a satisfactory definition of a *pure-bred*. Finally in 1883, acting on the insistent requests of American importers, the French breeders established a Record Association. They accepted as foundation animals only those draft horses found in the six provinces which comprised the old district of La Perche.

At once American breeders stipulated that imported horses, to qualify for entrance in the American Association books, must first be accepted by the French Society. This ended the embarrassing uncertainty; a breeder could now lay claim to the title "pure-bred" for a horse and could successfully establish his right to do so. Pure-breds were created by definition as a result of this action by the Society. But though the sale value of these horses was greatly increased, their biological nature was not changed. This word again depends for its meaning on the verdict of a body of men; it is in fact a civil, rather than a biological word. Biologically a horse may carry enough heritable traits to make him a high caste pure-bred Percheron, but if his ancestors lived across the line in Boulogne rather than in one of the six provinces originally specified by the French rules committee, he cannot claim that title, but must remain a Boulonnais.

Studies of Citrous Fruits

Study of citrous fruits at the California Agricultural Experiment Station has convinced the investigators that:

1. In all naturally fertile varieties of orange trees, self-pollination is the rule and cross-pollination unnecessary.
2. Viable pollen is either wanting or very scarce in parthenocarpic varieties—*i.e.*, varieties which produce fruit without seeds; the navel orange, for example.
3. The time required for complete fertilization after pollination varies with the variety from thirty hours in the Satsuma orange to four weeks in the wild *Citrus trifoliata*.
4. Normal embryo sacs are occasionally produced in the Washington Navel and Satsuma oranges. If such oranges happen to be pollinated with viable pollen from a nearby fertile variety, the result is the production of a few seeds in a navel orange. In other cases, even if pollination should take place, no seeds are produced because the embryo sacs in the navel orange disintegrate. In other words, navel oranges are seedless in most cases merely because they are not effectively pollinated and yet are able to produce fruit without such pollination.

Finally, the investigators have come to the conclusion that the origin of parthenocarpic citrus varieties—the navel orange, the seedless pomelo, etc.—is to be found in hybrids between naturally fertile varieties. The same explanation has been given for the seedlessness of the commercial banana and many other fruits. Such a theory, if it can be developed, opens the way for the commercial production of seedless fruits in many species where simple selection would be of little practical value. Extensive hybridization work is being taken up in citrus, while the study of purity of varieties has also received attention.

VALUE OF NEGATIVE EUGENICS

Measures That Are Possible Are Decidedly Worth Taking but Must Not Be Expected to Cause Any Great Amount of Race Betterment—Difficulties in the Way of Constructive Eugenics[1]

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NO WELL-informed person doubts that the principles of heredity and evolution apply to man as well as to the lower organisms and in spite of much controversy with respect to the importance of natural selection in evolution, I make bold to assert that no other principle has yet been suggested of equal importance with this, and that the elimination of the unfit affords not only the only natural explanation for the existence of fitness, but also the only means by which breeders have been able to improve domesticated animals and cultivated plants. The only possible control which mankind can exercise over the production of improved races of lower organisms or of men lies in the elimination from reproduction of the less favorable variations which are furnished by nature. For it has become more and more clear in recent years that, while environment exercises a great influence over the development of the individual, its influence on the germ plasm or the hereditary characteristic of the race is relatively slight and in general is not of a definite or a specific character. Probably environment may under certain circumstances modify the germ plasm, but there is no evidence that good environment will produce good modifications, and bad environment bad modifications in this hereditary substance. Consequently, the only method which is left to man for improving races is found in sorting out the favorable varieties from the unfavorable ones which are furnished by nature. If the human race is to be permanently improved in its inherited characteristics, there is no doubt that it must be accomplished in the same way in which man has made improvements in the various races of domesticated animals and cultivated plants.

Fortunately, or unfortunately, the methods which breeders use cannot be rigidly applied in the case of man. It is possible for breeders to eliminate from reproduction all except the very best stocks, and this is really essential if evolution is to be guided in a definite direction. If only the very worst are eliminated in each generation, the standard of a race is merely maintained, but the more severe the elimination is, the more does it become a directing factor in evolution. This may be illustrated by a diagram in which variations in all directions are represented by lines radiating from a central point. These lines may be thought of as being individually distinct, as in the "pure line" concept. If only those lines are blocked which lead in one direction, the center of radiation or "mode" would be but slightly changed in successive generations. But if all lines are blocked but those which lead in one particular direction, the mode will be rapidly shifted in that direction in succeeding generations. Therefore the value of selection as a directing factor in evolution depends on its severity.

MAINTAINING THE LEVEL

In the case of man, however, even the most enthusiastic eugenicists have never proposed to cut off from the possibility of reproduction all human stocks except the very best, and if only the very worst stocks are thus elimin-

[1] Paper read before the Eugenics Section, American Association for the Study and Prevention of Infant Mortality, Philadelphia, Pa., November 11, 1915.

ated, we must face the conclusion that practically all that can be accomplished will be to preserve the race at its present level. The ecstatic visions of those eugenicists who look forward to a world of supermen to be produced by this method of eliminating from reproduction the worst human stocks, can be regarded only as irridescent dreams, impossible of fulfillment. It is impossible, then, to apply rigidly to man the methods of animal and plant breeders. Society cannot be expected to eliminate from reproduction all but the very best lines. The great majority of mankind cannot be expected voluntarily to efface itself. The most that can be hoped for is that the great mediocre majority may eliminate from reproduction a very small minority of the worst individuals.

Furthermore, other and perhaps even more serious objections to the views of extreme eugenicists are to be found in human ideals of morality. Even for the laudable purpose of producing a race of supermen, mankind will probably never consent to be reduced to the morality of the breeding-pen with a total disregard of marriage and monogamy. The geneticist who has dealt only with chickens or rabbits or cattle is apt to overlook the vast difference between controlling reproduction in lower animals and in the case of man where restraints must be self-imposed.

Another fundamental difficulty in breeding a better race of men is to be found in a lack of uniform ideals. A breeder of domestic animals lives long enough to develop certain races and see them well established, but the devotee of eugenics cannot be sure that his or her ideals will be followed in succeeding generations. The father of Simon Newcomb is said to have walked through the length and breadth of Nova Scotia seeking for himself a suitable mate, but neither he nor any other eugenicist could be sure that his descendants would follow a similar course, and long continued selection along particular lines must be practiced if the race is to be permanently improved. Mankind is such a mongrel mixture, and it is so impracticable to exercise a strict control over the breeding of men, that it is hopeless to expect to get pure or homozygous stocks except with respect to a very few characters and then only after long selection.

But granting all these difficulties which confront the eugenicist, there is no doubt that something may be gained by eliminating the worst human kinds from the possibility of reproduction, even though no great improvement in the human race can be expected as a result of such a feeble measure. The question which has been assigned to me on this occasion is "How the Number of Births of Children Receiving a Faulty Heritage from their Parents May Be Reduced?" Strictly speaking, there is no one who does not receive a faulty heritage, at least in some respects; "there is none perfect, no not one." But there are some whose heritage is so faulty that they constitute a menace to society, and it is doubtless to these that this question refers. There are large numbers of persons, loosely called "defectives," in modern society, and it seems to be a question whether they are not actually increasing in number. This increase may be due, however, to a more accurate recognition and classification of defectives than prevailed formerly. There is no clearly and sharply defined class of defectives, but human populations show every gradation from the highest and most efficient individuals to the lowest and worst; strictly speaking, defectives may be said to include all individuals below the average, from subnormals to monsters. In general all defectives are shorter lived than normals, and the more serious the defect the shorter the life. The worst monstrosities die in the early stages of development, others live but a short time after birth, and none of these ever leaves offspring. Only those defectives in whom abnormalities are relatively slight ever reproduce. Nature has thus erected an insuperable barrier against the propagation of the worst.

ONE EFFECT OF CHARITY

Nevertheless a good many defectives survive in modern society and are capable of reproduction who would have perished in more primitive society before

reaching maturity. In the most highly civilized States the lives of these unfortunates are preserved by charity, and in not a few they are allowed to reproduce, and thus natural selection, the great law of evolution and progress, is set at naught. It is within the power of society to eliminate from reproduction this dependent class.

How can the number of defectives born from defective parents be reduced? Evidently if these defects are hereditary it can be done only by preventing their breeding, since in modern society defectives cannot be destroyed by Spartan methods. Many ways have been recommended and a few have been tried to accomplish this end, but they all come under two categories: (1) Segregation to prevent the union of the sexes, (2) sterilization or other means to prevent conception following sexual union. Such methods if rigidly applied to all defective or abnormal persons would doubtless reduce the number of "children receiving a faulty heritage from their parents," but since it is impossible for reasons indicated above to apply these methods to any except the most seriously defective class, which is usually dependent upon public care or private charity, and since in general the birth rate at present among such defectives is not large, no great change in the number of births of defective children through such elimination need be anticipated. And this is especially true since children inherit not merely the traits which their parents show, but also those family traits which are carried along in the germ plasm in a latent or recessive form, waiting only for an opportunity to become patent. The study of heredity shows that the normal brothers and sisters, or even more distant relatives, of defective persons may carry the defect in their germ plasm and may transmit it to their descendants though not showing it themselves. Such persons are more dangerous to society than the defectives themselves. And yet it is probably impossible rigidly to exclude them from reproduction

Finally, it is usually difficult and often impossible to decide whether a given defect is due to heredity or to environment; if it is due to the latter the methods adopted for its prevention must be wholly different from what they would be if it is due to the former cause. Experiments on guinea-pigs, rabbits and other animals show that serious defects may be produced in offspring by the action of alcohol and drugs on either or both of the parents before conception, and Forel with his wide experience in such matters does not hesitate to maintain that the effect of alcohol on either or both of the parents at the time of conception is one of the most fruitful causes of monstrous or defective children. No doubt there are many other environmental causes of defects in children, such as infection, malnutrition, injury, etc., at various stages in their development.

Dr. Henry H. Goddard, of the Training School at Vineland, N. J., has kindly furnished me with the following figures regarding the mental condition, so far as it has been investigated, of the parents of the inmates of that institution:

Number of families investigated	337 or 100%
Both parents feeble-minded	57 or 16.9%
One parent feeble-minded and other normal	43 or 12.8%
One parent feeble-minded and other unknown	54 or 16.0%
Family history of feeble-mindedness	154 or 45.7%
Both parents normal	90 or 26.7%
One parent normal, the other unknown	47 or 13.95%
Both parents unknown	46 or 13.65%

I am indebted to Dr. Martin W. Barr of the Pennsylvania Training School at Elwyn, Pa., for an extensive etiological table which he has prepared showing the probable causes of mental defect in more than 4,000 cases, from which I quote the following summaries:

	No. of cases	Percentage
Causes acting before birth	2,651	65.45
Family History of Idiocy and Imbecility .... 1,030 or 25.43%		
Causes acting at birth	186	4.59
Causes acting after birth	1,213	29.96
Totals	4,050	100.

Dr. George Mogridge, Superintendent of the Iowa Institution for Feeble-Minded Children has kindly supplied me with the following figures regarding the reported mental condition of the parents of persons who have been admitted to that institution, at the same time warning me that such statistics are not altogether reliable:

Number of families investigated	1,701 or 100.0%
Inmates who have both parents feeble-minded	66 or 3.88%
One parent feeble-minded and other normal or unknown	134 or 7.88%
Number with both parents normal	513 or 30.16%
Number with both parents unknown	876 or 51.5%
Insanity in one or both parents	112 or 6.58%

Defects, whether due to heredity or to environment, are multitudinous. Even feeble-mindedness is no simple thing; some persons are born fools, some acquire foolishness, and some have foolishness thrust upon them. Even with apparently good heredity and good environment the children of many excellent people are more or less defective, and at present we know of no means to reduce the number of such mistakes of nature. The eugenicist can sometimes "explain" such mistakes after they have occurred, though unable to predict them before the event. Indeed eugenical explanations are apt to be more convincing and accurate than eugenical prophecy; it is well to have eugenical insurance against having defective children, but it is advisable not to have all your insurance in one company.

NEW PUBLICATIONS

THE AMERICAN PET STOCK STANDARD OF PERFECTION and Official Guide of the American Fur Fanciers' Association. Compiled by J. Henri Wagner, president. American Fur Fanciers' Association, Washington, D. C., 1915; pp. 52, price 50 cents.

Breeders of rabbits, cavies (guinea-pigs), rats and mice are here provided with specifications, such as breeders of other animals and fowls have long enjoyed. In the case of many breeds, a brief account of the origin is given. Diagrams of color pattern and photographs of excellent specimens of each breed increase the value of the book as a work of reference for all who are interested in the smaller kinds of pet stock.

Inheritance of a Profile

At the Casalina estate, near Perugia, Italy, crosses are made between Rambouillet rams and Middle Tiber Valley ewes. The latter have a very convex profile of nose and forehead, as compared with the straight face of the Rambouillet; the results obtained lead to the conclusion that in the first hybrid generation all the crosses have a straight face profile, while the convex profile reappears in the second hybrid generation, in a ratio very nearly following the expectation for a recessive under Mendel's law—namely, one in four.—Carlo Pucci, director of the zootechnical laboratory of the Royal Agricultural Institute of Perugia, in *Il Moderno Zooiatro*, Bologna, April 30, 1915.

THE MARKING FACTOR IN SUNFLOWERS

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LAST year, working on the coloring matters in sunflowers, I made the unexpected discovery that the rays of a number of perennial species contain a substance which turns bright scarlet or vermillion in caustic potash solution. The annuals give no such reaction, and thus it is evident that although the *visible* colors in life may be exactly the same, there is still something fundamentally different, only revealed by a chemical test.

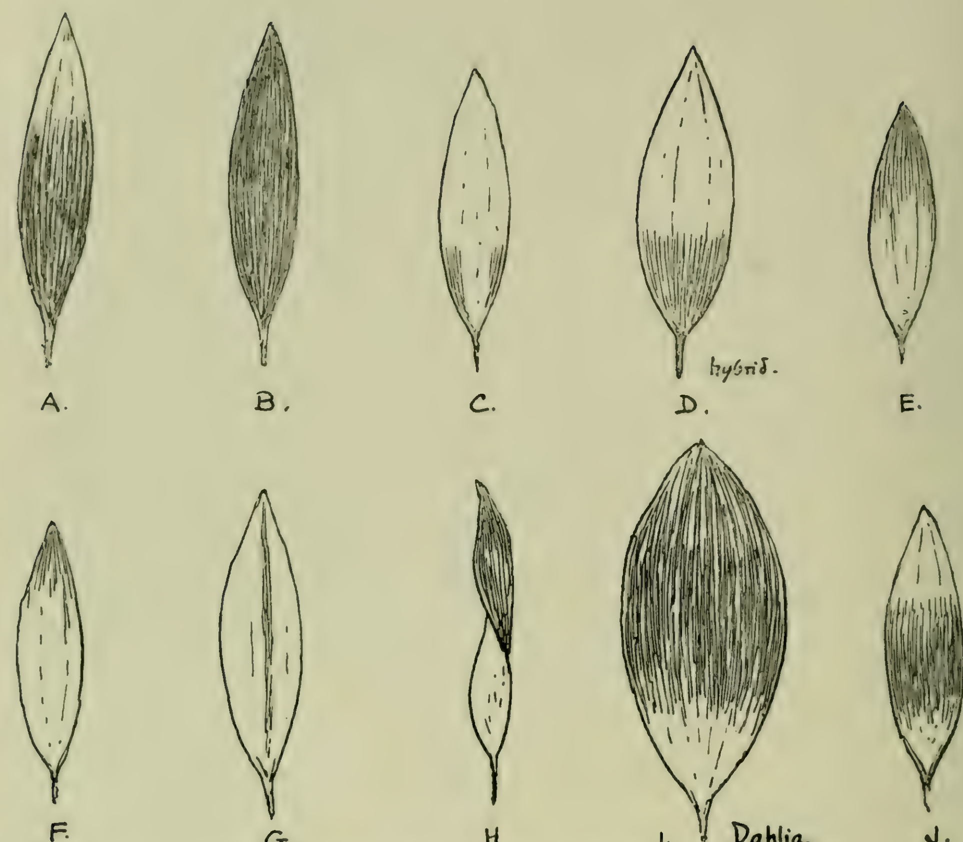
Another class of hidden characters has to do with the markings of those varieties which assume a red color. In the ordinary orange-rayed sunflowers it is often possible to detect a certain deepening of the color toward the base of the rays; sometimes this is quite conspicuous. Photographs of such flowers, taken without a color screen, accentuate this effect, and produce the appearance of strongly bicolored rays. A very remarkable instance of this sort was discovered by G. N. Collins in *Bidens heterophylla*, and published, with good illustrations, in *Plant World*, November, 1900. No species of wild sunflower has red rays, and yet in the red-rayed varieties developed under cultivation, or very rarely found wild as single sports, the distribution of the red is controlled by "marking-factors," which existed prior to and independently of the color-development through which they are made manifest. The independent existence of these marking-factors is shown not only by their behavior in heredity, but also by their partial or faint appearance in the orange (wild) forms, and their revelation through photography.

In the common garden sunflower, *Helianthus annuus*, or rather the series of cultivated forms we have obtained through crossing the original wild red sport (*H. annuus lenticularis* var. *coronatus*) with garden varieties, the marking-factors form a quite definite system. Their independence of the shade of color is shown by the fact that the chestnut-red (*coronatus*) and wine-red (*vinosus*) groups afford exactly parallel series of types. The commonest form (var. *bicolor*) has the basal half or more of the rays dark (chestnut or wine-red) and the apical part yellow or orange in the chestnut forms, primrose-yellow or very pale yellowish in the wine-red. Frequently, however, the base is pale (var. *zonatus*), and the red forms a ring around the head, crossing the middle of the rays. When the pattern-factor is absent, the whole ray is colored, chestnut or wine-red, as the case may be. Such forms frequently show yellow at the extreme base, and sometimes this becomes a definite spot or patch. In an occasional form there are two spots of color, either chestnut or vinous, one on each side of the basal part of the ray; the rest of the ray being orange or pale. (Fig. C). This I call var. *maculatus*. In the vinous or primrose-yellow it is a very pretty thing.

I was ready to suppose that this series of patterns would be found, quite the same, in all annual sunflowers which could be colored red. It turns out, however, that this is not true; that *Helianthus cucumerifolius* has a very different set of patterns. Some years ago M. Herb of Naples sent out what he called *Helianthus cucumerifolius purpureus*, a form with more or less red on the rays. The seeds first distributed produced very unsatisfactory plants, with very little red, and that dingy; but M. Herb persevered, and this year we have some very well-colored varieties raised from seed which he kindly sent. The patterns are on the whole very different from those of *H. annuus*. In the early cultures a common form (illustrated in Herb's catalogue for 1913) had the color confined to about a fourth

A PRODUCT OF SUNFLOWER BREEDING

In 1910, Mrs. Cockerell found near Boulder, Colo., a mutant from the familiar yellow sunflower. Its rays were suffused with chestnut red, which proved on examination to be due to anthocyan, a pink pigment that appeared chestnut because of its background. As there was but one of these mutants, and the sunflower is sterile with its own pollen, it had to be crossed back to the ordinary yellow form; when the seeds of this cross were grown, it was found that about half of the flowers had red rays. One of the forms isolated is shown above, and was named bicolor; in red forms of another species the pattern was reversed, the dark pigment being at the tips instead of the bases of the rays. It is evident from the photograph that there is a pattern factor which controls the distribution of the dark pigment. The presence of this factor would not be suspected in an ordinary yellow sunflower, although it is certainly there. The incident illustrates the fact that one can never know, from mere inspection, all the factors that any plant or animal has inherited, for many of them cannot get expression except under certain rare conditions. (Fig. 5.)



THE WORK OF FACTORS FOR MARKING

A represents the pattern of a ray of *Helianthus annuus*, var. *bicolor*, an entire flower-head of which is shown in Fig. 5. B is the same species, var. ruberrimus (or if the color is vinous, it is called var. vinosissimus); C is a new variety, maculatus, of the same species; D is a hybrid, *H. annuus* var. *coronatus* × *H. cucumerifolius*. E is a ray of the Red Lilliput sunflower of the trade, *H. cucumerifolius*, var. *apicalis;* F is another ray of the same form. G illustrates a new variety, *H. cucumerifolius* var. *vittatus*, and H is the variety purpureus of the same species. I is a dahlia ray and J comes from *Helianthus annuus* var. *zonatus*. (Fig. 6.)

of the ray, at the extreme base. A very pretty variety has the *ends* of the rays (half or less) delicately reddened, thus reversing the condition in *H. annuus* var. *bicolor*. It is this variety which was offered by Peter Henderson & Co. in their catalogue for 1915, under the name of Red Lilliput, with a rather over-colored but otherwise very characteristic figure. A more singular form, occurring in this year's cultures from Herb's seeds, has a variably distinct narrow red stripe down the middle of the ray (Fig. G); this occurs both on a sulphur yellow and a pale primrose background. Finally, we have obtained a plant in which the whole upper surface of the rays is a deep brownish-pink or dull crimson, while the under side is clear light sulphur yellow, in complete contrast (Fig. H). The contrast between the upper and lower sides is emphasised by the twisting of the rays.

All these plants from M. Herb's seeds are *H. cucumerifolius*, not hybrids with *H. annuus coronatus*, as is shown by the bracts. They have developed their red color quite independently of our *coronatus*.

We have raised a number of hybrids between our red *H. annuus* forms and the various forms of *H. cucumerifolius*.

These hybrids show the chestnut red color on the basal part of the rays, usually covering less than half of the ray (Fig. D). The general effect is quite different from that of *H. annuus* var. *bicolor*. A full description of one of the best of these hybrids is given in *Standard Cyclop. Horticulture*, Vol. III, page 1446.

This year we have obtained a very interesting hybrid, which may be called × *evanescens*. It is derived from a vinous *H. annuus* (v. *vinosus*) × a very pale *H. cucumerifolius*. The red color, therefore, comes from the *annuus* side. The disc is dark, and the rays vary from clear bright lemon (not orange) to pale primrose. When the flowers first open, the basal third or more of the rays is suffused with the anthocyan color, which in the lemon rays is a clear chestnut, often very bright and conspicuous. With time, this red color fades out completely, leaving in its place an orange suffusion. The appearance of the lemon-rayed variety from primrose or cream ancestry appears to confirm the suggestion made in a footnote in *Science*, August 21, 1914, to the effect that "the pigment of the primrose variety is quite the same as that of the lemon one, appearing paler only because not massed." The factor for *density* of pigment is apparently independent of that which controls the *kind* of pigment. The loss of the red color with maturity can be understood on the supposition that a deoxidising factor or substance (as described by Miss Wheldale) develops.

In the dahlia we find another series of color patterns, more or less like those of the sunflower, and similarly independent of the kind of color, whether scarlet or yellow, or vinous or white (compare the colored plates in *Gardeners' Chronicle*, March 14 and May 23, 1914). I figure, for comparison, a dahlia ray (Fig. I) in which the basal third or less is light yellow, and the rest vinous, reversing the condition of the *Helianthus cucumerifolius* × *annuus* hybrid.

Thus it appears that plants may contain determiners, or whatever we please to call them, which produce practically no visible effect in the normal forms, but which give rise to a complex series of effects as soon as anthocyan pigments appear in the rays. We are warned by such phenomena as these that our breeding experiments cannot always (? ever) be really restricted to a chosen set of characters; that other characters lie in wait, as it were, to confuse us and trip us up. In other words, the internal environment of the character studied cannot long be neglected, difficult as it may be to understand or to control.

Inheritance of Sex in Strawberries

Many thousand strawberry seedlings have been grown at the New York (Geneva) Experiment Station, including some 3,000 selfed plants which have come mainly from five parents. The problem with this fruit of chief importance to the plant breeder is the inheritance of sex.

While the main breeding work at this station is with fruit, yet the isolation of pure lines in varieties of peas, beans, cabbage and potatoes is also being carried on.

For nearly twenty years the general problem of the improvement of plants through bud-selection has been in hand. Originally this work was started with the Rome Beauty apple. It now includes also the Baldwin apple. In order to get results more quickly and to handle a larger number of individuals this problem is now being studied in the greenhouses by means of the English violet.

NATURAL SELECTION IN WAR

Conclusions as to Eugenic Results of Conflict Cannot Be Drawn Without Inquiry As to Very Large Number of Different Factors—War May Either Help or Hinder Race Betterment—Present Strife is Overwhelmingly Dysgenic in Effect

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THE unqualified statement that war is either eugenic or dysgenic in its effect on the human race, is found, on closer investigation to be unjustifiable. The modification of selection by war is far more manifold than the literature on the biological effects of war would lead the reader to suppose. All wars are partly eugenic and partly dysgenic. Some are mainly eugenic and others mainly dysgenic.

Natural selection should be subdivided into (1) lethal, that which operates through differential mortality; (2) sexual, that which operates through differential mating; and (3) fecundal, that which operates through differential fecundity. Again, selection operates both in an inter-group competition and an intra-group competition. We must, then, in analyzing the influence of any agency on natural selection, examine it under each of these six heads. In the case of war, however, we may eliminate fecundal selection, as it is little influenced. Still another division arises from the fact that the action of selection is different during a war upon the armed forces themselves and upon the population at home; and after the war, upon the nations with the various modifications that the war has left.

We will consider lethal selection first. To measure the effect of the inter-group selection of the armed forces, we have to compare the relative quality of the two races involved. The evidence for believing in substantial differences between races is based (*a*) upon their relative achievement when each is isolated, (*b*) upon the relative rank when the two are competing in one society, and (*c*) upon the relative number of original contributions to civilization each has made. Such comparisons lead us to reject the sentimental equalitarianism that denies race differences. While we admit of course a great deal of overlapping, there are, nevertheless, real average differences. To think otherwise is to discard evolution and revert to the older standpoint of "special creation."

The comparison of the quality of the two sides becomes more and more difficult as fighting is more and more between groups of allies which may differ greatly among themselves. Yet this by no means removes the inequality of the two sides taken each as a whole.

Without entering into the evidence at this time, we readily see that the eugenic effect of war would be very different according as the sides differ much or little. Yet this difference in quality, however great, will have no significance, unless the superior or inferior side is in general more likely to lose fewer men. Where the difference has been considerable, as between a civilized and savage nation, it has been seldom that the superior does not triumph with fewer losses. Victory, however, is influenced much less in these later days by the relative military efficiency of two single nations than by the success in making alliances with powerful nations. But such alignments are by no means always associated with better quality, because (*a*) there is a natural tendency for the weak to unite against a strong nation, (*b*) to side with a group which is apparently succeeding, and (*c*) the alliances may be the work

of one or a few individuals who happen to be in positions of power at the critical time.

HIGH QUALITY ON BOTH SIDES

In this present war the contrast is particularly noticeable, since on both sides the combatants are in so large a proportion members of the old Teutonic or Hebrew races, both stocks being preëminent for their contributions to science and art. In this very feature, it is probable that we have the most noteworthy dysgenic element in the present war.

As for the selection taking place within each of the struggling nations, we must consider first of all the contrast between the combatants and the non-combatants of the same age and sex. This difference depends largely on how the army in question was raised. Where the army is a permanent, paid force, it probably does not represent a quality above the average of the nation, except physically. When it is conscripted, it will be superior physically, and probably slightly in other respects. If it is a volunteer army, its quality will depend largely on whether the cause being fought for is one that appeals to adventurers merely or one that appeals to some moral principle. In the latter case, the quality may be such that the loss of a large part of the army will be peculiarly damaging. This situation is more common than might be supposed, for by skillful diplomacy and journalism, a cause which may be really questionable, is presented to the public in a most idealistic light. In the present war, the soldiers of each country have been made to believe that *they* are the glorious defenders against unprincipled aggressors.

Even within the army of one side, lethal selection is operative. Those who are killed are by no means a haphazard sample of the whole army. Among the victims there is a disproportionate representation of those with (1) dauntless bravery, (2) recklessness, (3) stupidity. These qualities merge into each other, yet in their extremes they are widely different. However, as the nature of warfare changes, with the increase of artillery, mines and bombs, and decrease of personal combat, those who fall are more and more chance victims.

In addition to the killed and mortally wounded, there are many deaths from disease or from wounds which are not necessarily fatal. Probably the most selective of any of these three agencies is the variable resistance to disease and the widely varying knowledge and appreciation of the need for hygienic living shown by the individual, as, for instance, less reckless drinking of unsterilized water. But here, too, in modern warfare, this item is becoming less selective, with the advance in discipline and in organized sanitation.

The efficiency of selection will be affected by the percentage that each side has sent to the front, if the combatants are either above or below the average of the population. A nation that sends all its able-bodied males forward will be affected differently from its enemy that has needed to call upon only one-half of its able-bodied men in order to win its cause.

THE POPULATION AT HOME

Back from the fighting lines of the contending sides, the conditions that prevail are rendered more severe in many ways than in times of peace. Poverty becomes rife, and sanitation and medical treatment are commonly sacrificed under the strain. During a war, that mitigation of the action of natural selection, so common now among civilized nations, is somewhat less effective than in times of peace.

After a war has been concluded, certain new agencies of inter-group selection arise. The result depends largely on whether the vanquished have had a superior culture brought to them, as in the case of the Philippines, or whether, on the contrary, certain diseases have been introduced or crushing tribute has been levied, as in the Franco-Prussian War, or grievous oppression such as befell the Hebrews in Egypt.

Sometimes the conquerors themselves have suffered severely as the result of

excessive spoliation, which has produced vicious idleness and luxurious indulgence, with the ultimate effect of diminishing the birth rate.

Within the nation there may be various results. Sometimes, by the reduction of overcrowding, natural selection will be less severe. On the other hand, the loss of that part of the population which is more economically productive is a very serious loss, leading to excessive poverty with increased severity in the action of natural selection. Selection is also rendered more intense by the heavy burden of taxation, as is now so evident in Great Britain directly, and in the very common depreciation of currency as in the Southern States after the Civil War.

Sexual selection as well as lethal is affected by war in manifold ways. Considering the armed force, there is an inter-group selection, when the enemy's women are assaulted by the soldiers. While this has been an important factor in the past, this is less common now, with better army discipline and higher social ideals.

Within the group, mating at the outset of a war is greatly increased by many hurried marriages. There is also sometimes an increase of illegitimacy in the neighborhood of the training camps. In each of these instances, these matings do not represent as much maturity of judgment as there would have been in times of peace, and hence give a less desirable sexual selection.

In considering the belligerent nation at home, the number of marriageable males is of course far less than at ordinary times. It becomes important, then, to compare the quality of the non-combatants and those combatants which survive and return home, since their absence during the war period of course decreases their reproduction as compared with the non-combatants. The marked excess of women over men, both during the war and after, necessarily intensifies the selection of women and proportionately reduces that of men, since relatively fewer men will remain unmated. This excess of women is found in all classes. Among superiors there are, in addition, some women who never marry from the lack of sufficiently eligible suitors caused by the war.

In the past, and still among many savage peoples, inter-group selection has been affected by the stealing of women from the vanquished. The effect of this has been very different, depending on whether these women would otherwise have been killed or spared, and also depending on the relative quality of their nation to that of their conquerors.

To sum up, we find there are so many features of natural selection, each of which must be separately weighed and the whole then balanced, that it is a matter of extensive inquiry to determine whether a certain war has a preponderance of eugenic or dysgenic results. In the present war it would seem that the high quality of both sides compared with the rest of the world is so predominant a dysgenic factor that, together with the other dysgenic features, the eugenic results are overbalanced. The human species therefore on account of this is at present declining in inherent quality faster than in any previous similar length of time.

Pure Lines in Cotton

The influence of environment upon pure lines is being studied in a systematic way by the North Carolina and Mississippi Experiment Stations, which are growing the same strain of cotton in the two localities, and carefully comparing the plants at different stages. The North Carolina Station is further making a study of inheritance and association of some of the important characters of the cotton plant. A study of the value of kernels of corn taken from different portions of the ear has been made and it has been found that those from about the middle produce stalks that yield most heavily.

THE SELF-STERILITY PROBLEM

Many Important Points in Fruit-Growing Still Await Explanation—Recent Progress in the Study—Need of Distinguishing the Various Factors Entering into the Problem[1]

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THE problem of the pollination of horticultural fruits has been, and is, a subject of great practical importance, and of much painstaking investigation. Nevertheless, results from carefully planned and skillfully conducted experiments frequently are so apparently contradictory that when the whole body of facts is considered, very few conclusions seem warranted. In the past far more has been concluded from the work of two, three or even five years than can be justified. The many questions which arise, especially as they relate to the sterility problem, will require, for their solution, years of patient labor. Such solution will not come from a mere dusting of stigmas with pollen in the springtime and an elaborate tabulation of results in the fall.

Still, the outlook is by no means discouraging. Every recorded fact, no matter how seemingly insignificant, is to be regarded as a step in advance even if for the moment it does seem merely to contribute to confusion. While it should be realized that a single fact is more valuable than extended interpretations of opinions based upon hasty observations or limited data, yet it is equally true that hypotheses are often useful and stimulating, and make for advancement in the understanding of facts. It should be remembered that they are hypotheses, and utilized as such; it is when they are regarded as hard and fast conclusions that they become dangerous. The investigator should be willing to discard hypotheses that are clearly shown by facts to be untenable.

The entire question of the causes of self-sterility quite generally in the plant kingdom, and in orchard fruits especially, is largely in the speculative stage. We are just beginning to bring together a great body of facts from which, in time, we confidently may hope to deduce some of the real fundamentals of the self-sterility problem. It should be understood at the outset that some of the statements made in this paper are speculative and consequently should not be regarded as conclusions. While based upon a large amount of experimental data they may be interpreted eventually in some other way.

DEFINITION OF TERMS

First of all, it is necessary that there be a clear understanding of certain terms which often are applied more or less indiscriminately. As used in this paper, a distinction is made between self-fertility, self-fertilization, and self-fruitfulness. The term fertilization is used in a strictly botanical sense; self-fertilization further restricts all gametes concerned to those derived from the same individual. In the case of varieties propagated vegetatively any so-called individual of that variety still would be considered as a mere part of the one individual. Self-fruitful is used to mean the ability of a plant to produce mature fruit, either without pollination (parthenocarpy) or when pollinated with its own pollen, whether or not fertilization takes place, or whether or not seeds are produced. It has reference to the development of vegetative parts only. A fruit tree, therefore, may be self-fruitful and self-sterile, or self-

[1] Read before the twelfth annual meeting of the American Genetic Association, at Berkeley, Cal., August 5, 1915.

CROSS-POLLINATION MAKES NO DIFFERENCE TO THESE APPLES

The Yellow Newtown apple, here photographed, is a self-fertile variety. At the left are three specimens which were produced as the result of cross-pollination; the specimens at the right arose from self-pollination. It is obvious that there is no gain in appearance from the cross-pollination. Growers may consequently feel safe in planting an entire orchard to this variety; while such a planting with some varieties that are not self-fertile, would result in very little fruit, because of the lack of opportunity for cross-pollination. Viable seeds are often produced by this variety but the seedlings are weak. (Fig. 7.)

fruitful and self-fertile. Barren and self-barren mean the absolute failure of a tree to produce fruit; the latter term, naturally would imply the lack of application of foreign pollen. The term fertile has been used to express the idea, both of production and capability of production. There is a definite distinction between the two ideas which should be observed, though it would be presumptuous to attempt to settle that question here. Since it seems more in line with usage in other biological sciences to regard fertility as synonymous with the actual production of viable offspring, germinable seeds are considered the true measure of fertility.

Let us consider briefly the term self-fertility. By it is meant the seminal production of independent offspring by an individual when not pollinated or fertilized by another individual. Generally this term has been applied to any plant which produces fruit with its own pollen. As indicated above, however, such an application is far too generalized, since a plant may be self-fertile and yet not be self-fertilized. Examples of such a condition at once come to mind in all cases of apogamy (including parthenogenesis), or vegetative apogamy. Again a plant may be self-fertilized and still not be self-fertile, if fertility is measured by viable seeds. Oftentimes even when actual fertilization has taken place, there is a failure of the embryo either to complete its development, or of the seeds to germinate. For the present discussion, the line which marks the division between the fertility and sterility of an individual is determined, arbitrarily, by whether its seeds do or do not germinate under normally favorable circumstances. This line of demarcation is arbitrary for several reasons; the chief of which is that whether a proembryo or an embryo fails soon after fertilization has taken place, or whether a fully formed embryo actually germinates and the seedling is markedly weak in constitution, the difference in development seems not so much one of kind as of degree. It does seem, however, that one of the definite division lines in the life cycle of a plant is marked by the phenomena of germination of the seed. While a fully matured seed may be called the new individual, throughout the following discussion only the germinated seed is so regarded. Consider in this connection, if you will, the frequent failure to hatch of the eggs of closely inbred domestic fowls, even though the best of incubation conditions have been provided and the eggs contain apparently perfect embryos; and also the premature birth which frequently takes place among animals when species are crossed, or, in common parlance, when the matings are not congenial.

For convenience, self-fertility may be considered to be of two types, first, that directly due to morphological factors, and second, that directly due to physiological factors. Like all classifications, no hard and fast line can be drawn between the two types—they are interdependent to no inconsiderable degree, as will be pointed out later.

MORPHOLOGICAL FACTORS

Morphological factors as causes of self-fertility are, as a rule, the most readily understood because of the relative ease with which they may be studied. Instances are of common occurrence. Beach and Booth have shown that under normal conditions certain self-sterile varieties of grapes are incapable of fertilizing other self-sterile varieties, which "is in many cases, if not all, due to a lack of potency in the pollen." A large proportion, or all, the grains are morphologically imperfect. Dorsey has recently shown that the cause of impotent pollen in the grape is due to "degeneration in the vegetative nucleus," and that in the impotent pollen of certain varieties no germ pore is present.

There is a wide variation in the germinability of apple pollen; it ranges from less than 1% to 100% according to variety. It also should be added that the percentage germination of any variety, even though apparently perfect morphologically, will vary from year to year and is dependent upon many factors such as age and general vitality of the tree, humidity before and during blooming time, soil conditions;

in fact, any environmental factor in the broadest sense of the term. Jeffrey recently has pointed out the widespread occurence of morphologically imperfect pollen in many plants, due, as he says, to the hybrid nature of such plants. Whether the same reasoning can be applied to account for morphologically defective pollen in all fruit varieties is still a question; apparently it accounts for some instances. Morphological imperfection is also of no uncommon occurrence among ovules, as is readily observable on inspecting the ovaries of most double flowers or of many varieties of fruits. There are degrees of imperfection, ranging from merely a lack of proper development of the egg apparatus to an almost complete degeneration of the entire ovule. According to Coit, some normal embryo sacs are produced in occasional fruits of both Washington Navel and Satsuma oranges. If disintegration of the embryo-sacs takes place, it may occur before the formation of the megaspores, but usually not until afterwards. He also states that viable pollen of parthenocarpic varieties is either entirely wanting or is very scarce.

Strictly dioecious forms unless parthenogenetic or apogamous are necessarily self-sterile. In the very interesting cases of total or partial change of the expressed sex of a plant, that is, staminate to pistillate or vice versa, as has been recorded for the Papaya and as has been known to occur to a lesser degree among the willows, sorrel, and some others, there arises a new situation; under the latter circumstances the abnormal individuals actually might be self-fertile.

In the class of morphological adaptations which make for self-sterility, also would fall all those numberless modifications of structure which bring about the prevention of self-pollination. Of course, through the agency of man, dichogamous flowers are capable of being self-pollinated, as they may be also in nature under exceptional circumstances, but as a rule a single flower of either type, when left to itself, would be sterile.

With respect to heterostyled plants, it has been suggested that perhaps the pollen tubes from the short styled flowers were not of sufficient length to penetrate to the eggs of long-styled individuals. It is an interesting suggestion but instances in which this has been investigated would not tend to bear it out. Cases are established in which the pollen tubes do not reach the eggs, but this result, so far as determined, is due to a physiological not a morphological cause.

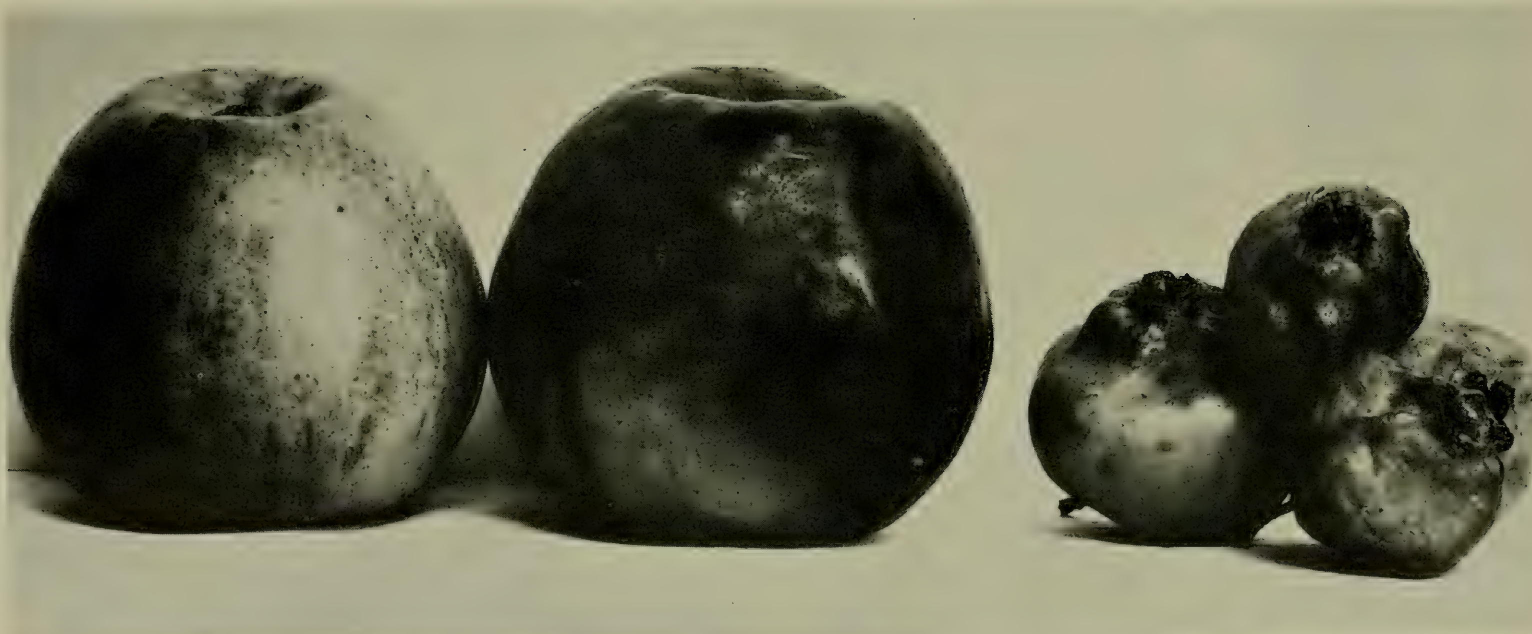
PHYSIOLOGICAL FACTORS

Passing now to a consideration of what may be termed the physiological causes of sterility, it will be observed that several classes can be made here, too. The first deals with those phenomena classed as chemotactic. This is no doubt a comprehensive grouping, and as more exact data become available, it may be shown that chemotaxis is but a temporarily assigned cause for results not now wholly understood. However, such a classification aids in furnishing a working basis for a consideration of available data.

The greater mass of evidence would indicate that in many instances, it is largely through chemotaxis that the pollen tube is directed in its growth to the embryo sac, and the sperms to the egg. Cases of self sterility which can be explained as having resulted from what may be termed negative chemotaxis are not unknown. To such a cause it seems preferable to ascribe such instances as have been recorded, in which, instead of a progressive increase in the rapidity of the growth of the pollen tube down the style, there is a progressive retardation, and finally total cessation of growth, but neither the conductive nor stigmatic tissues have been destroyed or perceptibly changed.

In his experiments with orchids, Fritz Müller found that not only was the pollen of a given plant, when placed upon its own stigma, prevented from germination, but also that there was a poisonous interaction of pollen and stigma.

To a third class, and so far as orchard fruits are concerned, by all odds the



IN THIS CASE CROSS-POLLINATION IS OF SOME IMPORTANCE

Under many circumstances the Ben Davis apple, here illustrated, is self-sterile, although it is sometimes self-fertile. The two fruits at the left come from a cross-pollination. At the same time, several hundred blossoms were carefully self-pollinated, and protected from contamination by wind or flying insects. The entire net result of these several hundred self-pollinations is seen in the three fruits at the right. These deformed fruits were infested by aphis or plant lice, a fact which seems to have some bearing on self-fertility, although its meaning is not yet clear. (Fig. 8.)

most important and inclusive, it is difficult to apply a short, descriptive term, though brief discussion will make clear its characteristics. The germination of the pollen grains upon the stigma, the growth of the pollen tube down the style, and generally the union of the proper nuclei within the embryo sac, are apparently normal. Now the interesting fact is, that further developmental phenomena proceed to varying degrees. That is to say, the post-fertilization processes may be normal, with a full and complete development of the endosperm and embryo, or there may be practically no development of the egg after its union with the sperm. All gradations exist between these extremes. Very frequently there is practically a complete development of the endosperm but a far less complete development of the embryo. The changes occurring in the ovule are reflected in the external appearances of the young fruits. Time and again there is an apparent set of fruit when blossoms are self-fertilized, but within a period of several days or weeks the young fruit turns yellow and finally drops. On cutting into such fruits to examine the seeds, a highly interesting situation is disclosed. If the fruit has fallen while still very small, it will be noted that there has been very slight development of the ovules, though there is evidence that the endosperm has begun development and often the embryo also, but only to a very slight degree. Fruits which have remained on the tree for a greater length of time generally show a much greater degree of development of endosperm and usually, though by no means always, a greater development of the embryo. Fruits which have fallen when half grown generally show what appears to have been a complete development of endosperm and the embryo clearly visible to the unaided eye, often filling half and sometimes a much greater proportion of the seed. It is interesting to note that in most self-sterile, but not self-fruitful or parthenocarpic, varieties of apples and pears, the extent of development of the embryo can be predicted with a high degree of accuracy from the observation of the size or weight of the fruit; the larger the fruit the greater the embryo development. This is in accord with the fact already well known that, under like conditions in varieties of apples and pears which are not parthenocarpic, there is generally an important correlation between weight of seed and weight of fruit. One more condition should be mentioned. In mature fruits, shrivelled seeds, which were apparently of full size before the shrivelling took place, are of common occurrence. Examination of such seeds discloses an entire lack of embryo or one exceedingly small and aborted. Earlier inspection shows the seed-coats filled with endosperm, which shrinks away on maturity of the fruit.

FAILURE OF EMBRYOS

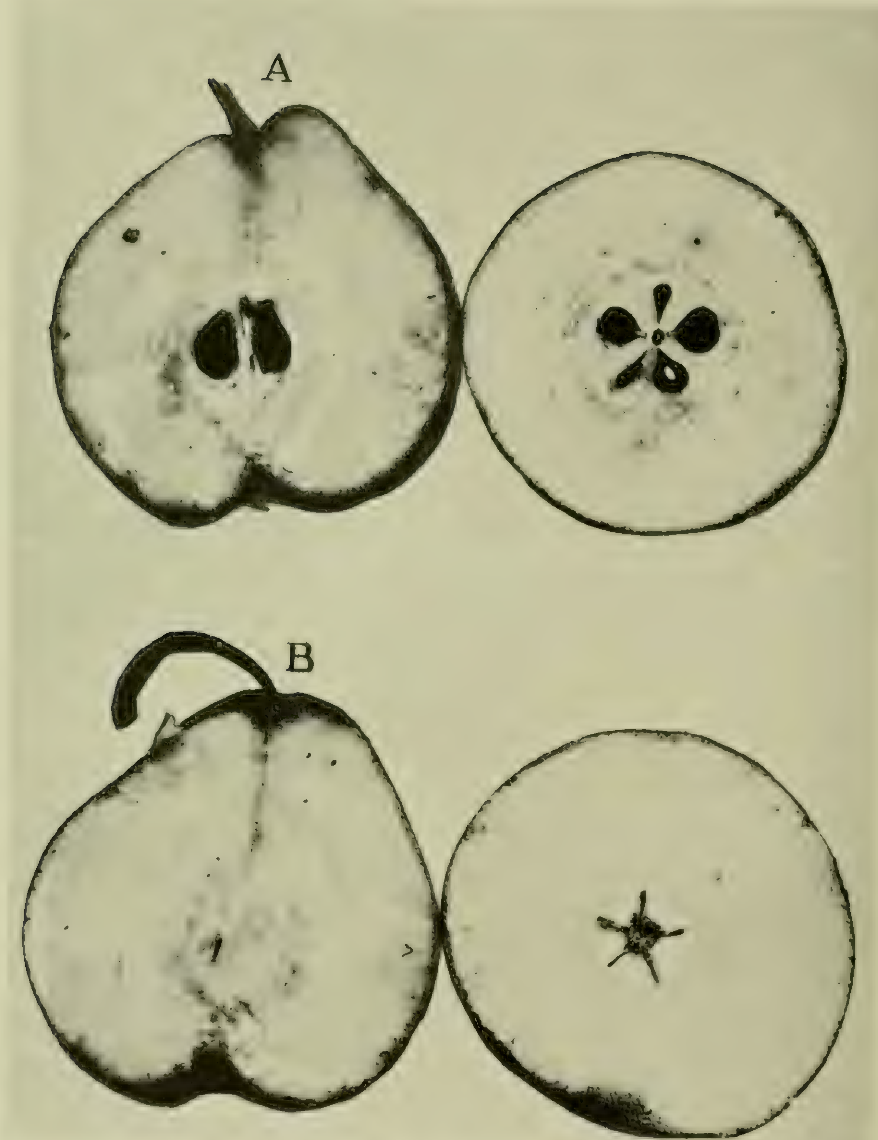
How to account for the failure of the embryos at various stages in their development is not entirely clear, but in a study of this problem, some interesting phases have arisen. In reference to pollination of orchard fruits, several records are available which state that the variety is self-sterile except for a few misshapen or small fruits harvested from clusters infested with aphids. In our own experiments, we have observed this same condition dozens of times. This setting in the presence of aphids has been explained on the grounds that the aphids, in crawling over the blossoms, carried the pollen on to the stigmas, whereas flowers simply inclosed in sacks were not so thoroughly pollinated. The view hardly seems tenable because, unless very hard pressed for time, even when flower clusters are tagged for self-fertility tests, we brush over the stigmas of the flowers with their own pollen; and the most frequently occurring condition of this kind with us is that due to the rosy apple aphis which works on the leaves in the cluster, badly deforming them, but, in most circumstances, does not come into contact with the fruit at all, though the latter is deformed also. In the case of apple varieties which normally are neither self-fertile nor self-fruitful, in other words self-barren, not only is it possible to cause the fruit to set if

aphids are present at blooming time, but it is actually possible to produce embryo-containing seeds, none of which have we ever succeeded in germinating. Accidentally and intentionally this result has been obtained many times. Of course, such fruits are usually deformed: the longer and more severe the infestation, the greater the deformity. Gardner has found in cherries a similar condition, produced by the black cherry aphis. None of the pits, however, matured embryos. There is a radical change in the vascular system of fruits badly deformed through aphis infestation and such fruits may remain hanging on the trees for several years. The greatest change, however, is that the embryo resulting from self-fertilization at times will complete its development under such circumstances and absolutely fails under normal conditions. It would seem that this peculiar behavior of aphis infested fruits has a fundamental significance, especially when considered in connection with a study of vegetative parts.

It was soon realized that to arrive anywhere in a study of this problem it would be necessary to begin such a study very early in the history of the flower. In our own work on the apple and pear, we have not only examined the fruit bud in its very beginning, but also the vascular anatomy of the spur or branch from which it arose. Why this latter seemed important will become evident directly. It has been demonstrated that morphologically defective pollen is present in many varieties of orchard fruits at the time the anthers open. At once the question arises, at what stage of development of the blossom does the abnormality of development occur, and what is the nature of such abnormality? Recent investigations have given one answer to the problem. The same question may well be asked regarding any abnormality of ovules. When there appears to be no particular abnormality of either pollen or ovules, one naturally seeks to discover other causes.

To observe that apparently there is a normal union of sperm and egg cells and nuclei, and then a varying development of endosperm and embryo from little more than none to complete, demands further search for the causes underlying such behavior. Anyone who has carried on pollination experiments knows full well that the application of so-called acceptable pollen does not necessarily insure fertility. To a lesser degree, the phenomena above enumerated under self-fertilization take place after cross-fertilization, and this is true even though pollen of the highest germinability be used.

Such a result leads one to look beyond the pollen and egg cells, important though they may be, and he is naturally led to question whether there is not something to be gained from a study of the nutritive processes of structures concerned in seed formation and development. Are there abnormalities of somatic tissue which actually preclude seed and fruit formation even though the eggs and sperms immediately concerned are not lacking in their essential qualities? Often the high percentages of apparent set from self-pollination or cross-pollination shrink to a discouraging zero before the maturity of the fruit. How often, too, a fair sized fruit is found to be without "plump" seeds. The careful observer has noticed that this latter occurrence is comparatively frequent among certain varieties and extremely rare among others. Is there a reason for this? What is the cause for certain varieties being able to produce seedless fruits when self-pollinated, while others absolutely fail to mature fruit unless good seeds are present? Or why will many fruits develop parthenocarpically? As more cases are investigated, the evidence of differences in texture and even chemical composition of seed bearing and seedless fruits, is increasing rapidly. Perhaps all are familiar with the differences in flavor and texture of seedless and seed bearing grapes in the same cluster. Hume has pointed out the differences in persimmons. English cucumbers are "often rendered unfit for use when they bear seeds." The quality and texture of apples and pears are distinctly different when the fruits have developed parthenocarpically. To me all this



THE PRODUCTION OF SEEDLESS PEARS

This is the Winter Nelis pear, a self-fruitful and, very rarely, self-fertile variety. Above is a fruit produced by cross-pollination, and having the full complement of seeds. Below is a fruit produced from self-pollination—it is entirely normal both size and shape, but has not a single seed. It has been determined that parthenocarpy—the production of fruits without seeds—occurs only rarely in this variety. (Fig. 9.)

points to a phase of the pollination and fertility investigations that have not received the attention they merit; namely, a thorough study of the vascular system of fruits. There certainly are varying degrees of interdependence of seed and flesh formation. This absolute dependence of some varieties upon the presence of seeds in order to reach maturity and the absolute independence of others raises a series of questions which as yet are not understood but deserve careful attention. Of course, they may have a more direct bearing in the problems of self-fruitfulness and parthenocarpy, but they are by no means to be disregarded in solving the problem of self-sterility.

STUDY OF THE CELL

The further study of the phenomena of gametogenesis and fertilization, especially as related to nutrition, is absolutely essential. Coulter's recent contribution on reproduction in plants, especially that portion which deals with the conditions under which gametes are formed, is most suggestive in this latter regard. Much more information is needed on nutrition and its relation to embryo development, and the interrelation of vegetative or somatic vigor to reproductive vigor. Cannot the one be measured in terms of the other to a considerable degree? The possibility of changing certain varieties from a self-sterile condition to a so-called self-fertile one by a change in nutrition is too well known to require more than mention, but the fact should not be overlooked that in the great majority of such cases actual self-fertility has not been induced but rather a condition of self-fruitfulness. In many varieties of apples, it is possible to bring about self-fruitfulness (without plump seeds) by a change in nutrition *and* self-pollination; it is much more difficult to do so when no pollination takes place. It seems that a stimulation of the ovules must be induced, and this stimulation transmitted to the vascular system; and that when a "tendency to develop" has been set up, the fruit continues to develop whether seeds are present or not. A greater expression of this "tendency to develop" is evident when fruit is produced without pollination, but some other abnormal condition of nutrition or stimulation has been applied to bring about the result. Its greatest expression is the production of fruit, normally parthenocarpic; a phenomenon purely vegetative in character, neither pollination nor abnormal stimulation having been required. It may be argued that the term "tendency to develop" explains nothing. Granted; however, it expresses an existing condition or relation, the fuller explanation of which will come from a more thorough study of vegetative parts, and a correlation of their structure and developmental behavior with fertilization and seed production, whether such correlation be positive or negative.

Home-grown or Foreign Seed

At the Maine Agricultural Experiment Station studies on inheritance in oats and beans, having regard to yield, color, and other characters, have been under way for some years; cross-bred apples are being studied, and the effect of selection in populations and pure lines is also the subject of investigation. In view of the importance of the oat crop in the state, that cereal has been given special attention, with the view of securing the best possible varieties for local conditions. The work was begun by a careful test of the varieties already in use, and continued by isolation of pure lines and by hybridization. The current idea among farmers that foreign-grown seed is better than home grown, has been found here, as elsewhere, to have little basis; frequently, indeed, a variety behaves much better after it has been acclimatized for a year or two.

PLANT BREEDING IN CUBA

Rich Opportunities for Geneticists—Attempts Made to Utilize Natural Resources—Interesting Problems of the Mango and Other Fruits

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A DISCUSSION of plant breeding in Cuba must necessarily deal more with opportunities than with accomplishments, since it is only in very recent years that any attention has been devoted to this subject, and the work is still in its infancy. Along several of the most important lines, however, a good start has been made, and with the remarkably rich field which Cuba possesses it is scarcely conceivable that the near future will not see some noteworthy advances in the development of new and superior forms of cane, tobacco, maize, vegetables and tropical fruits.

Naturally enough, when the improvement of Cuban crops was first taken up eleven years ago, when the senior author was called to the island to organize the Government Experiment Station, the most important cultures were the first ones to receive attention. The testing of seedling sugar canes has been carried on for the past ten or twelve years at the Harvard Experiment Station, which is maintained by Mr. Atkins, president of the American Sugar Refining Co., at his Soledad plantation near Cienfuegos. As is well known, sugar cane is usually propagated by planting the stalks; seedlings were first successfully grown by the British in Barbados and Demerara, but recently they have been propagated throughout the tropical world in great numbers, in the hope of obtaining varieties which would be more resistant to certain diseases or contain a greater amount of sugar. At Soledad the special problem has been to find varieties so well adapted to local conditions that the yield can be maintained in the face of lessened soil fertility due to long-continued planting to this one crop. The soils of the Soledad district are peculiar in not responding to the use of commercial fertilizers. Other Cuban soils, especially the red lands and the sandy loams, give excellent results when fertilizers are applied to them, and their productiveness can be maintained without difficulty. Since sugar cane occupies the land continuously for a number of years the soil cannot readily be improved through crop rotation or green cover crops. Stable manure is out of the question, hence when commercial fertilizers fail to give the desired results the problem is a serious one. What possible solution could be found for such an unusual problem—to make a plant continue to yield heavily while the soil in which it grows is being steadily exhausted? Few investigators would have thought of genetics as a solution; but the attempt to get around the situation through scientific plant breeding was made and is proving successful, since many of the seedlings are giving satisfactory yields even on thin and exhausted soils.

DISEASE RESISTANCE

In addition to the production of seedling canes which will maintain a profitable yield on poor soils, an effort has been made, in a very limited way, to obtain through selection strains which will be resistant to the root rot, a disease supposed to be caused by *Marasmius sacchari*. On virgin timber lands in Cuba cane will often continue to give profitable results for twenty or twenty-five years without replanting. At length, with soil exhaustion and the increase of disease due to continuous cultivation of this one crop, the fields die out and must be replanted every third or fourth year. The cane usually

A CUBAN FRUIT OF PROMISE

One of the things needed by tropical fruit growers is a satisfactory grape. Most of the grapes known to commerce are natives of temperate countries, and have never given satisfactory results in warm regions; hence good grapes are not now grown in tropical America. In the wild Caribbean grape here illustrated, however, is a plant which breeders can probably make serve their needs. It is found in many parts of Cuba and the West Indies, and even in a wild form its berries are as good as those of some of the North American wild grapes, which have been so admirably improved during the last century. There is reason to believe that the plant breeders can produce from this stock a grape that will meet their wants as well as the Concord and other varieties meet those of North America. (Fig. 10).

begins to die at certain spots in the field where growth is weakest, and the disease spreads in concentric circles until there are bare spots of an acre or more. Always, however, occasional stools survive in these diseased areas, and continued observation of this fact led to the conclusion that some of these stools represented plants which had greater resistance to the disease than the average. It is well known that varieties differ very noticeably in their resistence to the disease, and if particularly immune strains exist in the widely planted Cristalina cane, which is so satisfactory in Cuba from most other points of view, the fact is of the greatest importance. At one time this problem was taken up by the Cuban-American Sugar Co., and many strains were selected for trial. Unfortunately, the work was dropped before any results were obtained, but the question is one which promises to yield most valuable results when the necessary attention is given it.

While cane and tobacco[1] naturally occupy the most important places in Cuban agricultural investigations, to the plant breeder there is probably no field of greater interest than the improvement of tropical fruits. Cuba possesses unusually good opportunities for this work, due to the wide variety of fruits which are found in the island, and the great abundance of several of them, such as, for example, the avocado[2] and the mango.

The northerner coming to Cuba is apt to scoff at many of the native fruits, and to compare them unfavorably with the temperate fruits to which he has been accustomed. In doing so, he fails to remember that most of the tropical fruits—practically all with the exception of the pineapple and the banana—are nothing more than half-wild seedlings. In the majority of cases, even an occasional superior variety which may originate through seedling variation is lost because of the fact that vegetative propagation has never been generally understood or applied in the tropics. It is no wonder, then, that many of the tropical fruits, in their present state, are of rather inferior quality. On the contrary, it is doubtful if the wild prototypes of many of our cultivated temperate fruits are so attractive or so palatable as many of these tropical species which are in the same state of nature.

SELECTION OF FRUITS

The most obvious means of improving most of the tropical fruits, and the one which offers the most immediate results, is selection. With the great number of seedlings which are found in Cuba, it is not difficult to find occasional ones which are much superior to the average and worthy of propagation. We are just now getting to the point where we can bud or graft most tropical fruit trees, and hence the work of improvement is just being commenced. It can scarcely be said that Cuba is behind in this work, though more has been done in Florida in regard to working out methods of propagation which will permit choice seedlings of mangos, avocados and other fruits to be perpetuated. Efforts at hybridization have been few or practically none, yet in several respects this field, too, offers remarkably good opportunities.

The tropics have long been in need of a grape which would flourish and produce abundantly, the Malaga type (*Vitis vinifera*) as well as the North American varieties having proved to be poorly adapted to tropical conditions, though the South European grapes are occasionally grown in Cuba and other tropical countries with a certain degree of success. There exists in Cuba,

[1] A short paper on selected strains of tobacco was published by Dr. Heinrich Hasselbring as the result of his work at the Estación Experimental Agronomica. This is the only paper dealing with plant breeding that has yet been issued by the station, whose work was largely suspended for a number of years, because of political conditions, and has only recently been resumed with vigor.

[2] The avocado (*Persea gratissima* Gaertner, a member of the laurel family) is known in tropical America as aguacate, a name based on the Aztec name ahuacatl. Avocado is a corruption of this name, which seems to have become firmly established in the United States. The term "alligator pear" is also used in this country, but is misleading and objectionable.

THE CUBAN WALNUT

Good nuts are comparatively scarce in the tropics, and Cuban plant breeders have, therefore, a great opportunity in the possession of this wild species of walnut. It compares favorably in size of nuts with the North American black walnut, and should easily yield to selection and hybridization, as well as furnishing a stock on which to graft temperate varieties. Photograph from H. A. Van Hermann. (Fig. 11.)

however, a native species, *Vitis caribaea*, which might, through hybridization with some of the cultivated grapes, give rise to a race which would be of the greatest value to tropical regions. The vigor and productiveness of this wild grape suggest that it might also be of value as a stock on which to graft varieties of the vinifera type. Even in its present form this grape is equal, in size and quality, to many of the wild grapes of North America; the individual berries are about 3/8 of an inch in diameter, dark purple, juicy, and produced in good sized clusters. The plant is a strong climber, sometimes covering trees 18 or 20 feet high. At Santiago de las Vegas it has been cultivated on trellises and has done remarkably well. Two distinct forms have been noted in different parts of Cuba, one with a close, compact fruit cluster, the other producing looser clusters and fewer berries.

Another native plant of possible economic value has recently been brought to the attention of horticulturists by H. A. Van Hermann and Dr. Juan T. Roig. This is the Cuban walnut, *Juglans insularis*, a tree occurring in the mountains of the island and producing nuts which compare favorably in size with the northern black walnut. The kernels are difficult to remove from the shell, however, and the partitions are thick. The tree is not at all common, and horticulturally speaking it is practically unknown, yet it might be of great value as a stock on which to graft some of the cultivated walnuts, or through selection it might be considerably improved. There are very few nuts which succeed in Cuba, or in the tropics generally, and the addition of a walnut to those already cultivated would be a distinct advance. It may be mentioned that the Queensland Nut, *Macadamia ternifolia*, has been fruiting for several years at Santiago de las

Vegas, and gives promise of becoming a valuable thing.

OPPORTUNITIES WITH THE MANGO

In all parts of the island the mango is one of the most abundant of fruits. During July and August it reigns supreme, filling the markets everywhere. Many Cubans prefer the mango to all other fruits, though there are some who would place the pineapple and the anón (*Annona squamosa*) ahead of it, and a few might even consider the sapote or sapodilla (*Achras zapota*) superior. With very few exceptions, however, the varieties or types of mango grown throughout the island are inferior ones, scarcely worthy of propagation, and the opportunity for improvement is great.

Nearly all Cuban mangos are polyembryonic, and reproduce themselves more or less true to type when grown from seed. This peculiarity of certain mangos has been recognized for some time; many years previously, however, when English horticulturists took up the improvement of the mango in India, they found that seedlings from the best varieties were usually much inferior to the parent, and they were forced to depend upon vegetative propagation for the perpetuation of good mangos. The Indian mangos, in many cases at least, are monoembryonic, and seedlings do not come true to type. The West Indian mangos are separable into numerous groups, and it has long been known to the natives that a seed from a mango of any given type would produce a mango of the same type; this reproduction of type is so perfect, indeed, that among twenty or thirty seedlings of one type the fruits will be as similar in every character as the fruits of a grafted variety. The explanation is to be found in the polyembryonic character of the seeds.

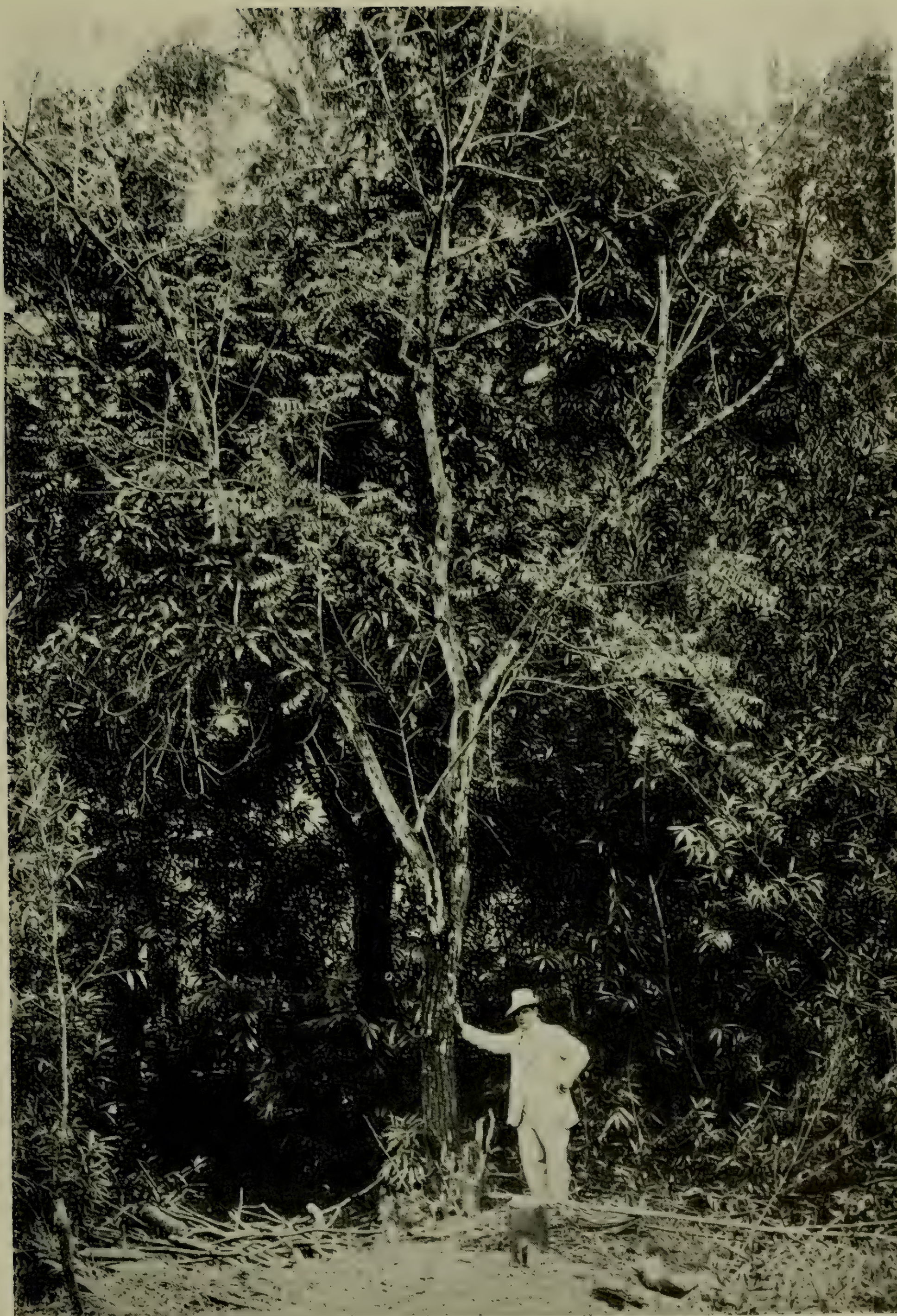
Putting the case as simply as possible we may say that the plants which grow from the seed are not derived from a fertilized sexual cell, as is usually the case in the vegetable kingdom, but arise as buds in the tissues which surround the female cell in the ovary. Thus the question of sex does not enter into the origin of these plants any more than it does into the propagation of a geranium by cuttings of the fleshy stem. The mango tree produced in this fashion naturally reproduces the characters of its parent as truly as does a tree propagated by the ordinary means of grafting, since it is a case of vegetative reproduction in both instances.[3]

WELL-DEFINED TYPES

The commonest Cuban mangos are divided into two races, known to the natives as *mango* and *manga;* the former is a tall, erect tree, sometimes 60 feet high, with an oval, open crown, the fruit elongated, laterally compressed, usually curved and beaked at the apex, the fiber surrounding the seed long and coarse. The *manga* race, on the other hand, is a low, spreading tree, 35 or 40 feet high, with a dense, dome-shaped or flat-topped crown, the fruit scarcely compressed laterally and lacking a beak at the apex, the fiber more abundant than in the *mango* race but much finer. Two principal types of the *manga* race are distinguished, *manga amarilla*, an elongated fruit with orange colored flesh, and *manga blanca*, an obliquely spherical form with pale yellow flesh. Both these types are very well defined and one may find trees in various parts of the island which produce fruits absolutely identical in appearance and character. Another race which is less common but very highly esteemed is the Filipino, which is believed to have come from the Philippines by way of Mexico; this is a rather small, erect tree with a dense oval crown, producing elongated, slender fruits, compressed laterally, with very little fiber and of excellent flavor.

Besides these principal races and types, there are to be found, principally at Cienfuegos and in the vicinity of Santiago de Cuba, several less important types, which though very limited in distribution are very superior in quality. The *Chino* and *manga Mamey* of Cienfuegos, and the *Biscochuelo* of Santiago de Cuba, are among the best of these, fruits of all three being shipped to the Habana markets, where they sell at 10 to 25 cents each. These types have originated in certain gardens, where seeds have been brought from other West Indian islands or possibly from the Orient. In most cases they have been propagated locally, and the fruit produced by seedlings of the original tree or trees proves the remarkable constancy of the polyembryonic mangos.

[3] John Belling demonstrated that the embryos, which vary in number from two to eight or ten, are derived from the tissue of the endosperm by budding. Whether the ovum itself develops into an embryo or not has never been ascertained; if it does, the effect of cross-fertilization might be shown, and more variation evidenced in the plant from the fertilized ovum than occurs in those plants which arise from adventive embryos.



TREE OF JUGLANS INSULARIS

This wild Cuban walnut is somewhat rare in the mountains of the island, and has only recently been called to the attention of horticulturists by Van Hermann and Roig. (Fig. 12.)

A DELICIOUS FRUIT FROM SOUTH AMERICA

The cherimoya has been called by some writers one of the world's finest fruits. Its rough green skin encloses luscious, melting pulp of custard-like consistency, piquant and delicate in flavor, suggesting pineapples and bananas. While its native home lies within the tropics, it only attains perfection at high altitudes, where the atmosphere is cool and the soil well drained. It has been grown with remarkable success in subtropical regions such as southern California and Madeira, where the conditions of climate and soil approach those of its native home—believed to be the Andes of Peru and Ecuador. The cherimoya (*Annona cherimola*) has been in cultivation for a long time, and numerous varieties have originated. (Fig. 13.)

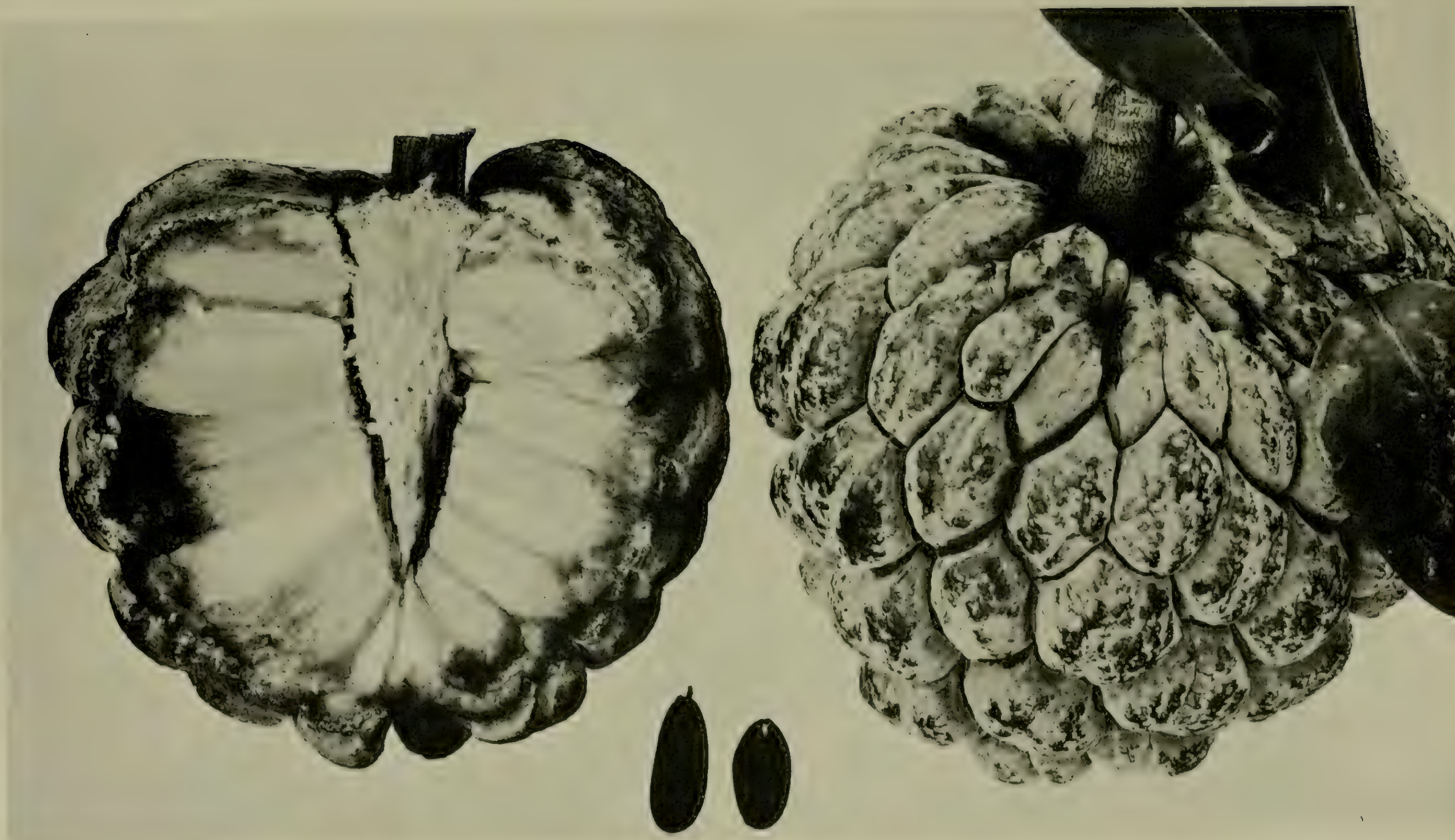
The most important work in mango improvement yet done in Cuba consists in the selection and propagation of some of these superior seedlings. While the effect of this work is not yet very noticeable, it has served to show what can be done, even by such simple means, and without the aid of budding or grafting. Now that these methods are being applied, however, the opportunities are much greater, and choice monoembryonic varieties can be perpetuated as well as the polyembryonic ones.

THE AVOCADO

The avocado is another favorite of the Cubans, and a fruit which takes a very important place in their dietary during the summer months. It is esteemed by all classes, and forms a substantial part of almost every meal; it is appreciated so highly, in fact, as to have given rise to a common saying, "No puedo comer sin aguacate"—"I cannot eat without avocado."

Everywhere throughout the island the avocado grows abundantly. Naturally enough, the trees are all seedlings, with the exception of the few budded orchards which have recently been planted, and among them there is the greatest variation in size, shape, color and quality of fruit, as well as in productiveness and season of ripening. Unlike the mango, the avocado does not come true from seed, and seeds from an oval green avocado may produce round, oblong or pyriform fruits of green or purple color, smaller or larger than the parent, and varying in other characters as well. For this reason the Cubans do not recognize any different classes of avocados, but call them all *aguacate* without distinction.

From the standpoint of plant breeding, much has already been done in



A FAVORITE CUBAN FRUIT, THE SUGAR-APPLE

While belonging to the same family as the cherimoya, the sugar-apple (*Annona squamosa*) succeeds in strictly tropical regions, and has spread from its native home in America to all parts of the tropical world. It is a favorite fruit in Hindustan, where it has become naturalized and forms dense thickets. In flavor it is sweeter and less piquant than the cherimoya, and there is a much smaller proportion of flesh to seeds. It was crossed with the cherimoya in order to produce a fruit suited to tropical conditions which would have the flavor of the cherimoya and the productiveness of the sugar-apple. (Fig. 314.)

Florida to improve the avocado through selection of seedlings, and Cuba has taken advantage of this by importing budded stock of selected varieties from Florida. In Cuba itself a few selections have been made, yet the field has scarcely been touched, and there can be no doubt but that there are many valuable forms to be found among the Cuban seedlings. The most important point in the selection of varieties at the present time is lateness of ripening, since it is the late fruits which bring the highest prices when shipped to northern markets. Here and there throughout the island are found occasional seedling trees which hold their fruit until December, January or even February. These should be hunted out and propagated.

THE CUSTARD-APPLES

Other Cuban fruits which undoubtedly possess great possibilities in the hands of the intelligent horticulturist, first through vegetative propagation of the best existing seedlings, then through further improvement by selection and hybridization, are the annonas, especially the anón (*Annona squamosa*), known in English as sugar-apple, and the guanábana or sour-sop (*A. muricata*). Hybrids between the sugar-apple and the cherimoya (*A. cherimola*) made by Edward Simmonds in Florida have demonstrated the possibilities along this line. The cherimoya, without doubt the finest flavored of the cultivated annonas, does not attain perfection in a truly tropical climate. The sugar-apple, on the other hand, is perfectly at home and fruits abundantly. The hybrid between these two species is a plant with foliage remarkably similar to that of the cherimoya, and with fruits a little larger than the average sugar-apple, with the carpellary divisions less deeply incised, and with a more pleasant, slightly acidulous flavor, almost midway between that of the cherimoya and the sugar-apple. It fruits somewhat more abundantly than the cherimoya but less so than the sugar-apple. Crosses should be made in Cuba between these species as well as between the sour-sop and the cherimoya.

Previous to the American intervention, citrous fruits were grown in Cuba almost exclusively from seed. Valuable seedling types, particularly of oranges, are often encountered growing half wild in neglected gardens and fence rows. In the early days of the Estación Experimental Agronomica (the Government Experiment Station at Santiago de las Vegas) the work of searching out and propagating these desirable seedlings was commenced, but was not carried very far. Undoubtedly when completed it will yield some valuable results in the way of varieties adapted to Cuban conditions. Other fruits, such as the caimito or star-apple (*Chrysophyllum cainito*) the sapote or sapodilla (*Achras zapota*), the mamey Santo Domingo (*Mammea americana*), the mamey colorado (*Lucuma mammosa*), and the common guava (*Psidium guajava*), all of importance in the economy of the Cuban people, will doubtless come in for their share of attention in later years.

IMPORTANT VEGETABLES

Many of the more important tropical vegetables, such as sweet potatoes and yams, malanga (*Colocasia* sp.) and yuca (*Manihot utilissima*), all of which are widely grown in Cuba, are propagated asexually. The opportunity for selection is not lacking, however, since bud variation seems to be much more common in the tropics than in temperate regions. Existing varieties of these crops are usually very local in distribution and few attempts have been made to determine which are the most valuable and best adapted to different conditions. In sweet potatoes, an important piece of work has recently been undertaken by Dr. Juan T. Roig of the Estación Experimental Agronomica, who has assembled a collection of varieties, over eighty in all, from different parts of the island, and is now determining the comparative value of each.

Northern vegetables of many kinds are successfully grown in Cuba during the winter months. Certain varieties

HYBRID BETWEEN CHERIMOYA AND SUGAR-APPLE

In this interesting hybrid, which was the result of pollinating the stigmas of the cherimoya with pollen of the sugar-apple, one can see several characters of each parent. The leaves are broad, resembling those of the cherimoya, but smooth like those of the sugar-apple. The protuberances are more distinct than in the cherimoya, but less deeply incised than in the sugar-apple, while the seeds are somewhat distinct from those of either species, larger than those of the sugar-apple and darker colored than those of the cherimoya. The flavor is about midway between the two species. The tree fruits more freely in Florida than the cherimoya, and seems much better adapted to strictly tropical conditions. This represents one of the first efforts along a line of plant breeding which holds great promise for all tropical countries. (Fig. 15.)

of each kind have been found to succeed better than others, but no systematic effort has been made to determine which are the most desirable ones from all points of view, nor to develop new ones in those cases where none of the introduced varieties is satisfactory.

Maize, or Indian corn, is another crop that presents great opportunities for selection and improvement. During the early years of the Estación Experimental Agronomica a great number of varieties from all parts of the United States and Mexico were tested, but none proved to be well adapted to Cuban conditions. The common variety cultivated in the island was originally of a yellow flint type; the ears are unusually heavily protected with husks which completely close at the tip, and the husks, leaves and stalks are abundantly covered with a thick white

tomentum. This seems to protect the young leaves while still inrolled in the apex of the growing stalk from the attacks of numerous small insects, which are always seen working about them. It is apparently the attacks of these insects that prevent the successful cultivation of smooth leaved northern types of corn in Cuba. The heavy husks, which serve to protect the ears from the attacks of the corn weevil, are doubtless the result of unconscious selection, since under the conditions which exist in Cuba only the ears which are so protected can be successfully kept from the time they are harvested until the next planting season. Large quantities of dent corn are annually imported into Cuba from the United States and from Argentina. Some of this has occasionally been planted and has developed sufficiently to produce pollen, ears of native corn occasionally being found which show more or less evidence of having been fertilized by dent pollen. The problem now is to select the best of these acclimatized crosses and breed from them in the hope of fixing a type which will combine the long ears and deep kernels of the dent type with the heavy husk of the native flint. This work was commenced at the Estación Experimental Agronomica, thirty of the best obtainable ears being selected and planted in different rows. The plants in each row, *i.e.*, those from a single ear, were fairly uniform in character, but among the different rows there was a most interesting diversity in vigor and height of stalk, productiveness, shape and size of ears, and in time of maturing.

The future of Cuban plant breeding cannot fail to be of interest. In few tropical countries are the opportunities more numerous and the conditions more favorable. That the Cubans themselves are awakening to the value of this work is demonstrated by the increasing amount of attention being devoted to it at the Estación Experimental Agronomica under the present administration,[4] and it is to be hoped that a great deal will be done by the planters themselves, some of whom are in a position to accomplish important results with the expenditure of very little time and energy, because of the wealth of material which exists all about them.

[4] The Cuban Secretary of Agriculture has recently had a report made on the importance of plant breeding, which it is hoped will lead to the commencement of extensive projects. In this report, written by Armando Lora, the establishment of a new station for plant breeding alone is urged.

Genetic Study of Apples

Apple breeding was begun at the New York experiment station (Geneva) in 1898–99; 148 seedlings of the crosses then made have fruited and have been described in Bulletin 350 of this station. With the exception of these, work with apples is still in an early stage, but further results are soon to be expected, as 1,200 seedlings are now ready to fruit. In addition to these about 2,500 seedlings will be planted in experimental orchards in the next two years. It is hoped that this number of seedlings will enable the investigators to analyze the genetic characters of the parents which have been used. Self-seedlings, because of lack of vigor, have not proved desirable from a horticultural standpoint and since so much time and effort is involved in the growing of apple seedlings, it has not seemed desirable to use selfing as a means of studying the parents. The data from these seedlings should throw light on the inheritance of skin and flesh color, form and size of fruit, season of ripening and quality.

REBUILDING THE LEGHORN

IT IS only about three-quarters of a century since the domestic fowls of Italy were brought to the United States and formed the basis of the Leghorn breed. In their native home they were, and are, largely mongrel in character, with various colors of plumage, legs, face and ear-lobes. Taken up by expert breeders in this country, they gave rise to eight standard and four non-standard varieties, of which the Single Comb White and Single Comb Brown are by all odds the most important, commercially.

From America the Leghorn was taken to Germany, where it goes under the name of Italian. Here, too, it was taken up by artists in breeding, but they were unable to produce the great egg yield for which the breed is noted in America, according to Professor Ehlers of Hanover, who describes the situation in the Mitteilungen of the Deutsche Landwirthschafts-Gesellschaft for October 9, 1915.

A prolonged test at the experiment station of Maryland resulted in egg yields averaging 171 in the first year the hens laid, 149 in the second year, and 115 in the third year. At the New York station, a flock maintained for some time gave 144 eggs as its highest yearly production and 132 as its lowest.

Citing these figures, Professor Ehlers says they cannot be equaled by German Leghorns. It is evident to him, therefore, that the capacity for high egg yield must be elsewhere than in the high comb with carefully incised teeth, the long wattles, the great white ear-lobes and the fancy feather patterns, on which the German breeders have spent so much energy.

Dissatisfaction with the behavior of the Leghorns has led, he reports, to a feeling that the breed should be made over into a typical German breed, possessing a rose comb and short wattles, which will in his opinion give it a smarter appearance. By the introduction of new blood, it is hoped to increase the egg yield. He does not say what new blood is being used: in the United States the Hamburg has been the breed employed in the production of the rose comb Leghorns which are fairly widespread.

CHANGE WELL UNDER WAY

This German undertaking, Professor Ehlers writes, "has secured the approval and support of the Board of Agriculture in the Rhine province, and the director of the winter school in Hermeskeil has had since the year 1912 two flocks each consisting of a dozen hens and a cock, which he has carefully and intelligently bred to the point of fixity, with most satisfactory results. When this undertaking is carried to its conclusion, the Italian race will have become a pure German race with higher productivity, just as the Leghorn has become a definite and superior American race.

"To Director Barth belongs the honor of having produced and disseminated a 'first class' genuine German fowl, a general purpose breed with regular, well-developed bodily form and pure color. In its general appearance it recalls the old and unfortunately extinct Alsatian breed. At the exhibition of the German Agricultural Association in Strassburg, 1913, a first prize and gold ring were given to one cock in recognition of this achievement in breeding, and at the circuit fair in Hanover, 1914, first prize again gave recognition to its supremacy in egg production. At high altitudes, where

Year	Number of hens	Number of eggs laid	Average per hen	Average weight of egg
1910........	8	1,018	127	54 gr.
1911........	11	1,463	133	56
1912........	18	2,482	138	59
1913........	24	3,667	152	63
1914........	26	4,019	154	65

THE ITALIAN FOWL IN AMERICA

Single Comb White Leghorn Cockerel bred at the Bureau of Animal Industry Experimental Farm, Beltsville, Md. This is perhaps the most popular breed for egg production in the United States. In Germany, according to Professor Ehlers, the breeders have spent all their time on developing fancy points, and have failed to raise the egg yield. It is therefore proposed to rebuild the breed in Germany, making from it a distinctively German breed with rose comb. Photograph from the United States Department of Agriculture. (Fig. 16.)

the single comb and wattles are likely to freeze in cold weather, the rose-comb breed has proved particularly valuable. Farmers praise its usefulness, its hardiness, and its egg yield, even where the single comb is at its best. As to the egg production of his breed, Director Barth gives statistics [found on page 569].

"The figures show that as the breeding continues, the egg yield of the fowls continues to increase pretty steadily, not only in number laid but in weight of each individual egg. In the last year reported, we have figures that exceed all expectations and are but little short of the figures reported by experiment stations in the United States."

The
JOURNAL OF HEREDITY

A monthly publication devoted to Plant Breeding, Animal Breeding and Eugenics.

JANUARY, 1915

ORGAN OF THE
AMERICAN GENETIC ASSOCIATION, Washington, D.C.
Printed for Circulation among Members Only

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"An exact determination of the laws of heredity," says William Bateson, "will probably work more change in man's outlook on the world, and in his power over nature, than any other advance in natural knowledge that can be clearly foreseen." To gain this knowledge is the object of the science of genetics, which proceeds in practice, largely by means of plant breeding and animal breeding, for the reason that heredity is less complicated in these organisms than in Man, and its operation can be more easily made out. The knowledge so gained finds its application in methods for the improvement of cultivated plants and domesticated animals and, most important of all, in the improvement of the human race through the science of eugenics, which was defined by its founder, Francis Galton, as "the study of agencies under social control that may improve or impair the racial qualities of future generations, either physically or mentally."

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Through its committees on research, co-operation with which is not obligatory, but is urged upon every member, the association collects information by means of approved scientific methods applied to the subject of genetics. This information, as well as that derived from other authoritative sources, it endeavors to place before the public by means of its committee on education and extension, and before its membership, in an attractive and understandable way, through this magazine. The association constantly strives to further the cause of conservative, constructive science and to check the progress of fallacious and sensational pseudo-science. While it can not assume responsibility for the accuracy of statements made by contributors to The Journal of Heredity, it endeavors to publish only such as are on a sound scientific basis, and members are urged to contribute such articles, with illustrations. The magazine does not pretend entirely to cover the immense field of genetics, but it is designed to keep members informed of the latest results in research in the most interesting lines, and to present these results in such a way that they will appeal not only to the specialists, but to the general reader who desires to know what the specialists are doing in a science that is of such personal importance to each individual.

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APRIL, 1915

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The JOURNAL OF HEREDITY

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AUGUST, 1915

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OCTOBER, 1915

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Vol. VI,

NOV 15 1921 W. R. Sullivan DEC 8 '2

FEB 27 1924 W. Jackson JUN 3 1924

MAY 17 D. Bennett JUL 9

JAN 9 1967 R Ward